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ABSTRACT

This unit was developed as a guide for use by Kentucky teachers in planning and conducting young farmer/adult farmer classes in the use of agricultural pesticides. The unit contains seven lessons covering the following topics: understanding the importance of agricultural pesticides; using and handling agricultural pesticides safely; developing a comprehensive pest control program; and using herbicides, insecticides, fungicides, and miscellaneous pesticides. The lesson format was designed to assist teachers in using problem-solving techniques and the discussion method. Each lesson contains an objective, problem and analysis, outline of content, and suggestions for teaching the lesson, including enrichment activities and resources. Transparency masters are contained in each lesson, and a list of resources to be used with the unit is included in the package. (KC)

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AGRICULTURAL PESTICIDES

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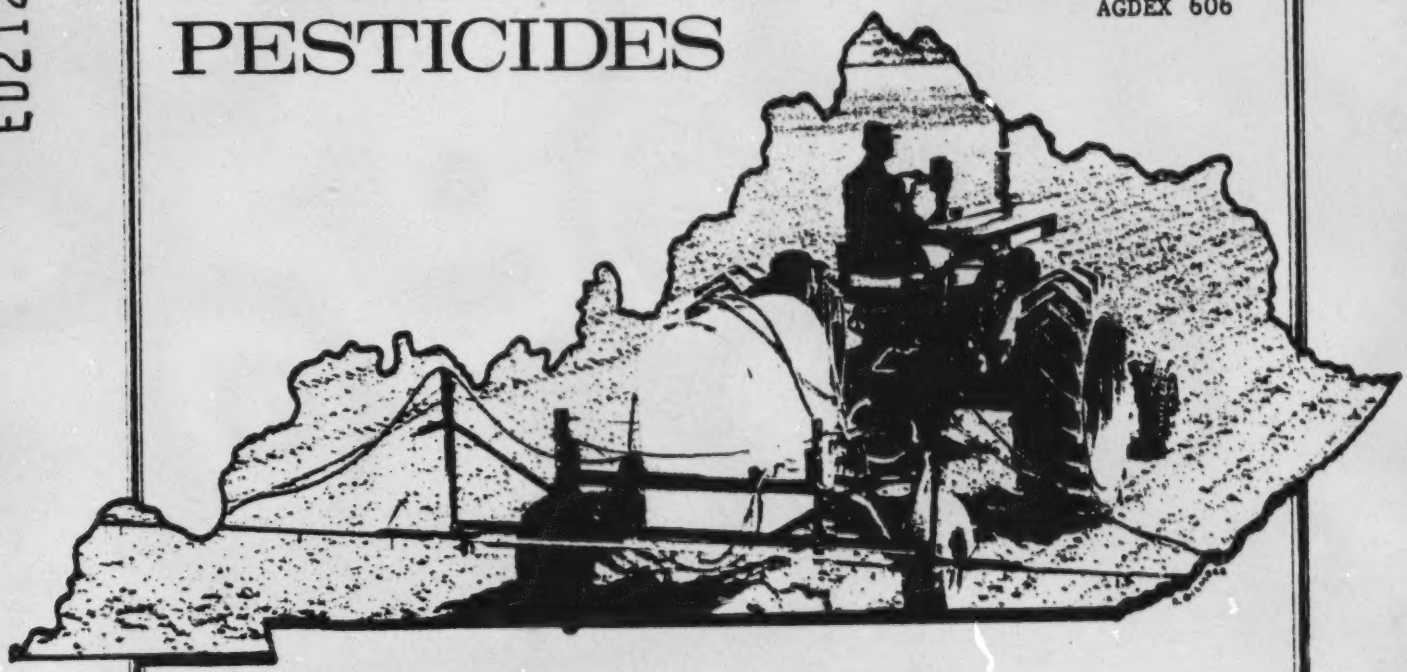

AN INSTRUCTIONAL UNIT for TEACHERS of ADULT VOCATIONAL EDUCATION in AGRICULTURE

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Kentucky Department Of Education

1981

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AGRICULTURAL PESTICIDES

An Instructional Unit for Teachers
of Adult Vocational Education in Agriculture

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1973

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1981

CE031605

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SUGGESTIONS FOR USING THE UNIT

This unit was developed as a guide for use by teachers in planning and conducting young farmer/adult farmer classes. Because of the diversity in age, expertise and experience levels of class members and instructors, the unit was designed to cover the basic areas of agricultural pesticides. Therefore, teachers should adapt those portions of the unit that are suited to their particular situation. Seven lessons have been included, but the unit may be expanded to more topics or utilized in diversified courses for shorter periods of instruction. It may be helpful to involve class members at the organizational meeting in the selection of lessons and activities. We highly recommend that teachers planning to utilize this unit secure a variety of references, many of which are available from the Cooperative Extension Service. Transparency masters are also available from a number of sources listed in the Unit References.

The format used was designed to assist teachers in utilizing problem-solving and the discussion method. A teaching procedure that has been used successfully is as follows: Step 1: The teacher lists the topic (problem and analysis) on the chalkboard. Step 2: The teacher then starts the discussion with introductory facts, ideas, or comments, using items from the section on "developing the situation." Step 3: The teacher calls on the class to give their experiences, ideas, and knowledge concerning the subject. The discussion is supplemented with handouts, transparencies, models, or other inputs gathered by the teacher beforehand to help solve the problem under consideration. Resource people or films may also be used here as sources of information. (Transparency and handout masters are found at the end of each lesson in the unit.) Step 4: When the facts have been brought out and a good discussion has taken place, the teacher leads the group to appropriate conclusions. These summary statements are written on the chalkboard and in some cases are typed up and distributed as handouts at the next meeting. Some instructors will utilize devices such as panels, exhibits, and tours to reinforce the conclusions reached. Several suggestions for supplementary enrichment activities are listed in each lesson of the unit. Step 5: Opportunities should be given for class members to practice the skills discussed in each lesson, preferably on the members' farms.

Teachers may want to utilize the wealth of resources found in each community to supplement their teaching -- local applicators, chemical company representatives, and others will undoubtedly be pleased to serve as resource people, furnish samples, give demonstrations, conduct tours, arrange for films and assist with other activities appropriate to the success of the course.

Each teacher using the unit is asked to complete and return the evaluation questionnaire found in the Appendix. These ratings and suggestions

will be used to improve this unit as well as others developed in the series.

Best wishes for a successful adult program.

Guy Taylor

John W. Dickens

DISCLAIMER

Agricultural practices and recommendations are in a state of flux. While efforts have been made to provide the most up-to-date information, the user must assume final responsibility before implementing this information.

Chemical products named are for examples only. Current recommendations may be found on product labels.

No criticism is meant of products not named nor endorsement for products mentioned.

UNIT OBJECTIVES

Major Objective: To develop the ability of farmers to use agricultural pesticides properly.

Lesson Objectives: To develop the ability of farmers to:

1. Understand the importance of agricultural pesticides.
2. Use and handle agricultural pesticides safely.
3. Develop a comprehensive pest-control program.
4. Properly utilize herbicides in controlling weeds in the commonly grown crops.
5. Properly utilize insecticides in the commonly grown crops.
6. Properly utilize fungicides in plant-disease control.
7. Properly utilize miscellaneous pesticides for several common problems.

Each teacher should list the specific skills that are to be accomplished by class members upon completion of a lesson. This can be written as the teacher decides what is to be included in a particular lesson. Class members may help in determining the skills to be developed.

Skills to be developed:	Can Do	Cannot Do
Lesson 1:		
2:		
3:		
4:		
5:		
6:		
7:		

UNIT REFERENCES

Books

Complete Guide to Pest Control--With and Without Chemicals by George W. Ware (Thomson Publications, P. O. Box 9335, Fresno, California 93791) 1980.

Doane's Farm Management Guide, Edition 12. (Doane Agricultural Service, Inc., 8900 Manchester Road, St. Louis, Missouri 63144) 1978.

Farm Chemicals Handbook, 1981. (Meister Publishing Company, 37841 Euclid Avenue, Willoughby, Ohio 44094.)

Fundamentals of Entomology and Plant Pathology, Second Edition, by Louis L. Pyenson (AVI Publishing Company, Inc., Westport, Connecticut) 1980.

Insects--The Yearbook of Agriculture, by USDA (United States Government Printing Office, Washington, D.C. 20402) 1952.

Pesticide Application Methods, by G. A. Matthews (Longman, Inc., New York, New York) 1979.

The Pesticide Book, by George W. Ware (W. H. Freeman and Company, San Francisco, California) 1978.

1981 Weed Control Manual, Ag Consultant and Fieldman. (Meister Publishing Company, 37841 Euclid Avenue, Willoughby, Ohio 44094).

Other Publications

Apply Pesticides Correctly: A guide for private applicators. (United States Environmental Protection Agency and United States Department of Agriculture, Washington, D.C.) 1975.

Applying Pesticides: Management, Application, Safety. Package containing a Manual, Teacher Guide, Student Workbook, and Slide-Tape Series. (American Association for Vocational Instructional Materials, 120 Engineering Center, Athens, Georgia 30602) 1976.

Handbook of Agricultural Charts, 1981. (USDA, Agriculture Handbook No. 551, U. S. Government Printing Office, Washington, D.C. 20402). Note: Supplement contains large-size charts.

Handling and Using Pesticides Safely, VAS 4045a, 16 p. (Vocational Agriculture Service, 434 Mumford Hall, Urbana, Illinois 61801).

Integrated Pest Management: A Program of Research for the State Agricultural Experiment Stations and the Colleges of 1890. (Study conducted by the Intersociety Consortium for Plant Protection, J. L. Apple, Chairman, Raleigh, North Carolina) 1979.

Other Publications (Cont'd)

Kentucky Agricultural Statistics. 1979-80. (Kentucky Crop and Livestock Reporting Service, P. O. Box 1120, Louisville, Kentucky 40201) September, 1980.

Kentucky Integrated Pest Management Scout Manual by Harley Raney, et. al. (Cooperative Extension Service, University of Kentucky, Lexington, Kentucky) undated.

Pest Management Strategies in Crop Protection, Volume I (Office of Technology Assessment, Washington, D.C. 20510) 1979.

The Pesticide Review: 1978 (Agricultural Stabilization and Conservation Service, USDA, Washington, D.C.) February, 1980.

Principles of Pesticide Use, Handling, and Application: Instructional Modules for Vocational Agriculture Education. (Developed for Office of Pesticide Programs, Environmental Protection Agency by Ellis Associates, Inc., College Park, Maryland 20740) 1976.

Problems for Pesticide Calibration - Student Manual, 12 p. (Vocational Agriculture Service, 434 Mumford Hall, Urbana, Illinois 61801).

Problems for Pesticide Calibration - Teacher's Key, 12 p. (Vocational Agriculture Service, 434 Mumford Hall, Urbana, Illinois 61801).

Tips and Facts for Continued Safe Use of Pesticides, 16 p. (Vocational Agriculture Service, 434 Mumford Hall, Urbana, Illinois 61801).

Weed Control - Cultural and Chemical by Harlan Ridenour, et. al, (Ohio Agricultural Education Curriculum Materials Service, The Ohio State University, Columbus, Ohio 43210) 1978.

Magazines/Newsletters

Ag Consultant and Fieldman. (Meister Publishing Company, 37841 Euclid Avenue, Willoughby, Ohio 44094). Formerly Agriculture Fieldman and Consultant.

Crops and Soils. (American Society of Agronomy, 677 Segoe Road, Madison, Wisconsin 53711).

The Kentucky Farmer. (Cockrel Corporation, Route 9, Box 79EE, Bowling Green, Kentucky 42101) March, 1980.

Cooperative Extension Service, University of Kentucky
(Contact your county Extension Office for available publications)

AGR-6 Chemical Control of Weeds in Farm Crops in Kentucky - 1981

1981 Insect Management Recommendations for Field Crops and Livestock
Included are Publication #'s:

- ENT 11 Control of Beef Animal Insects
- ENT 12 Control of Lactating Dairy Cattle Insects
- ENT 13 Soybean Insect Control
- ENT 15 Insecticide Recommendations for Tobacco Beds and Fields
- ENT 16 Insecticide Recommendations for Conventional and No-Tillage Corn
- ENT 17 Insecticide Recommendations for Alfalfa and Clover Pest Management
- ENT 22 Controlling Insects on Sheep and Goats
- ENT 23 Insecticide Recommendations for Swine
- ENT 24 Small Grain and Grain Sorghum Insect Control
- ENT 28 Control of Poultry Insect Pests

ENT 18 Insect Control for Home Vegetable Gardens

ENT 19 Controlling Insects in Stored Grain

ENT 20 Grain Sorghum Insects

ENT 25 Soybean Insects

ENT 26 Safeguard Yourself ... When Using Insecticides

ENT 34 Livestock Insects

ENT 36 Fly Control Around Dairy Farms

ENT 37 Insect Pests of Dairy Cattle

ENT 39 Beef Cattle Pests

ENT 40 Tobacco Insect Pests

ID- 8 Strawberry Insect and Disease Control - 1980

ID- 21 Disease and Insect Control Program for Home Grown Fruit in Kentucky

ID- 45 Tobacco Handbook

PPA 3 Soybean Cyst Nematode

PPA 8 Chemical Controls for Tobacco Plant Bed Diseases

Picture Sheets:

1 Principal Stored Grain Insects

2 Common Household Pests

3 Common Tree and Shrub Pests

4 Corn Insects--Above Ground

5 Corn Insects--Below Ground

6 Common Soybean Insects

7 Common Small Grain Insects

8 Common Forage Legume Insects

11 Stinging and Biting Pests

Films/Slides/Transparencies

Diseases of the Vegetable Garden, filmstrip or slides, (Vocational Agriculture Service, 434 Mumford Hall, Urbana, Illinois 61801).

How Herbicides Work Transparencies. (Vocational Agriculture Service, 434 Mumford Hall, Urbana, Illinois 61801) undated.

Identifying Common Insect Pests, filmstrip or slides, (Vocational Agriculture Service, 434 Mumford Hall, Urbana, Illinois 61801).

The Pesticide Review Process, filmstrip, (Vocational Agriculture Service, 434 Mumford Hall, Urbana, Illinois 61801).

Safe Use of Pesticides Around the Home, filmstrips or slides, (Vocational Agriculture Service, 434 Mumford Hall, Urbana, Illinois 61801).

Safe Use of Pesticides Transparencies. (Vocational Agriculture Service, 434 Mumford Hall, Urbana, Illinois 61801) undated.

Weed Control Transparencies. (Ohio Agricultural Education Curriculum Materials Service, The Ohio State University, Columbus, Ohio) 1970.

Weed Control Transparencies. (Vocational Agriculture Service, 434 Mumford Hall, Urbana, Illinois 61801) undated.

Lesson 1

IMPORTANCE OF AGRICULTURAL PESTICIDE USAGE

Objective: To develop the ability of farmers to understand the importance of agricultural pesticides.

Problem and Analysis: How important are agricultural pesticides to modern farming?

- Economic importance to producers
- Economic importance to consumers
- Trends in pesticide usage
- Classification of agricultural pesticides
- Pesticide terminology

Content

I. Economic Importance to Producers

A. Annual potential loss to crops in the United States from plant insects and diseases is estimated at twenty billion dollars, much of which can be controlled by proper use of appropriate pesticides. Failure to maintain adequate control results in the following:

1. Decreased yield
2. Lower quality of produce
3. Reduction in growth and vigor of plants
4. Death of plants

B. Nationwide, annual losses due to weeds and the expense of control runs into five billion dollars.

1. It is estimated that severe losses of corn to weeds may amount to $80 or more per acre. Kentucky farmers in 1978 spent $12.02/acre for herbicides and $2.75/acre for insecticides for corn. Soybean herbicide costs amounted to $12.39/acre, fungicides cost $ .08/acre, and insecticides cost $ .25/acre. The annual average price that U. S. farmers paid for 5 gallons of 2,4-D increased from $18.50 in 1969 to $38.50 in 1979. Thus, costs associated with pesticides are significant.

2. Use of herbicides to control weeds results in increased yields and a lowered cultivation cost.

3. Around-the-farm weed control means greater efficiency and safer and more pleasant working conditions.

4. Use herbicides for weed control whenever weeds are unsightly, a severe source of weed seed, or when they create hazardous conditions as follows:

-- Along fence rows
-- In barnyards and around farm buildings
-- In roadways and driveways
-- In storage areas for oil or gasoline
-- In storage areas for machinery, equipment, supplies, grain, and in field lots.

C. Economic injury to livestock from insects may result in:

-- loss of animal condition due to blood sucking insects
-- loss of production and quality due to the invasion of animal tissues by parasitic stages of insects
-- losses from diseases transmitted by insects
-- losses from self-inflicted injury as they flee pests
-- loss of production due to poor nutrition when animals go off feed attempting to get away from insect attack.

These injuries total hundreds of millions of dollars annually.

II. Economic Importance to Consumers

A. Few countries today excel the United States in food quality and quantity available to the consumer.

B. Due to increased technology (including pest control), each farmer produces enough for self and 59 others today, as compared to enough for one other, self, and family in the early 1900's.

C. In the United States, the consumer spends 19 percent of his family's disposable income for food, in Canada 22 percent, and in the Phillipines 62 percent.

D. One-third of the world's food crops are destroyed by pests during growth, harvesting, and storage.

III. Trends in Pesticide Usage

A. More than $304 million were spent on pesticides (insecticides, fungicides, nematicides, and herbicides) in the United States during the 1978 growing season. About 8% was spent for fungicides, representing a considerable outlay for the control of plant diseases. About one-third of the purchases were for insecticides, while over half (58.6%) went for herbicides.

B. The sharply rising production of agricultural pesticides is one measure of their value in agriculture for controlling disease-bearing pests and for other uses. United States production of pesticidal chemicals was more than 1.4 billion pounds in 1978; this included: fungicides (147 million pounds), herbicides (664 million pounds), and insecticides (605 million pounds). The U. S. imported 74 million pounds of pesticides in 1978; however, pesticide exports for that year amounted to 677 million pounds.

IV. Classification of Agricultural Pesticides

A. There are a number of general classifications of pesticides that need to be defined. (See Pesticide Terminology for definitions) When agricultural pesticides are mentioned, often the first thing that comes to mind is weed spray. While the weed killers are the largest group of pesticides, by pounds used, there are others which need to be considered. The two major groups are insecticides and herbicides.

B. Other common pesticides include the following categories:

1. Fungicides, nematicides, rodenticides, algicides
2. Disinfectants, growth regulators, defoliants, repellants, attractants

In 1980, the U. S. Environmental Protection Agency had more than 1,200 pesticides registered.

C. Pesticides may also be classified by the way they work. These include contacts, stomach poisons, systemics, translocated herbicides, and fumigants. Each of these pesticides may be selective or nonselective in their actions.

D. Pesticides may also come in many different formulations, requiring different methods of application. Some of these formulations include:

Liquid Formulations

Aerosols	(A)
Emulsifiable Concentrates	(EC or E)
Flowables	(F or L)
Liquified Gases	
Paint-on Lacquers	
Solutions	(S)
Ultralow-Volume Solutions	(ULV)

Dry Formulations

Adhesive Tapes & Strips	
Baits	(B)
Dusts	(D)
Feed-additive	
Granules	(G)
Soluble Powders	(SP)
Vapor-producing Candles	
Wax Bars	
Wettable Powders	(WP or W)

Formulations are dealt with more extensively in following lessons.

V. Pesticide Terminology

(To establish an understanding of terms that apply to pesticide usage, refer to masters of terms included at the end of lesson.)

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:

1. Pesticides are playing an increasing role in the production of agricultural products, both crop and livestock.

2. A comparison of two inputs of production--fertilizers and agricultural chemicals--shows that fertilizers have been higher priced than agricultural chemicals since the year 1974.

3. Of the consumer dollar, the consumer spends about 19 percent for food.

4. Regulations and restrictions on continued use of pesticides are increasing, and regulations are enforced by the Environmental Protection Agency (EPA).

B. Things to be brought out by class members:

1. Their experiences with pesticides (successful and unsuccessful results).

2. Trends in personal usage of pesticides.

3. Opinions on what it would be like to farm without the use of pesticides.

II. Conclusions

A. Pesticides are one of the accepted tools of production.

B. Agricultural pesticide usage is increasing each year.

C. Regulations and restrictions on pesticidal use are going to increase. Therefore, an increase in knowledge and responsibility will be required on the part of each user, in order to meet certification requirements (discussed later).

III. Enrichment Activities

A. Use chalkboard with suggested form to draw on student experiences with pesticides.

B. Display samples of packaged pesticides, such as insecticides, herbicides, fungicides, and any other available from a local dealer.

IV. Suggested Teaching Materials

A. References for Lesson 1

- Complete Guide to Pest Control: With and Without Chemicals
- Handbook of Agricultural Charts - Supplement 1981
- Kentucky Agricultural Statistics, 1979-1980
- The Pesticide Handbook

B. Resource Personnel

1. Cooperative Extension Specialist
2. Consult local sources

C. Audio-visuals

1. Masters*

- Inventory of Pesticide Usage (Table)
- Share of After-Tax Income Spent on Food
- Prices of Selected Farm Inputs
- Use of Selected Farm Inputs
- Prices Received and Paid by Farmers
- Pesticide Terminology

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*Masters are keyed to units and lessons, and are numbered consecutively. The code number appears in the lower right hand corner. Master 109A-1-1 indicates: adult unit 109A, lesson 1, item 1.

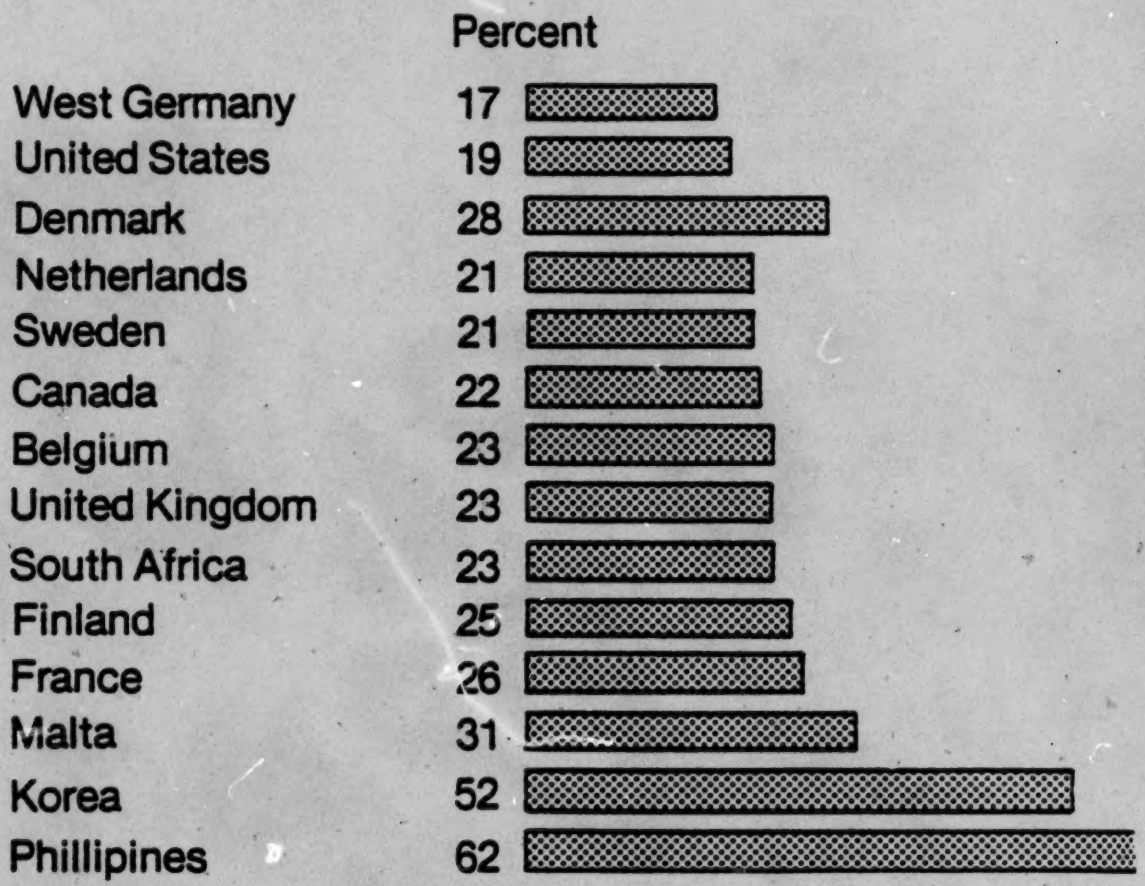
INVENTORY OF PESTICIDE USE

NAME _____

WHERE HAVE YOU USED THESE PESTICIDES?	POSSIBLE AREAS									
	TOBACCO	CORN	SOYBEANS	HAY CROPS	VEGETABLES	BEEF	DAIRY	HOGS	OTHER LIVESTOCK	BLDGS.
INSECTICIDES										
FUNGICIDES										
HERBICIDES										
RODENTICIDES										
ACARICIDES (Miticide)										
AVICIDES										

109A-1-1

Share of After-Tax Income Spent on Food

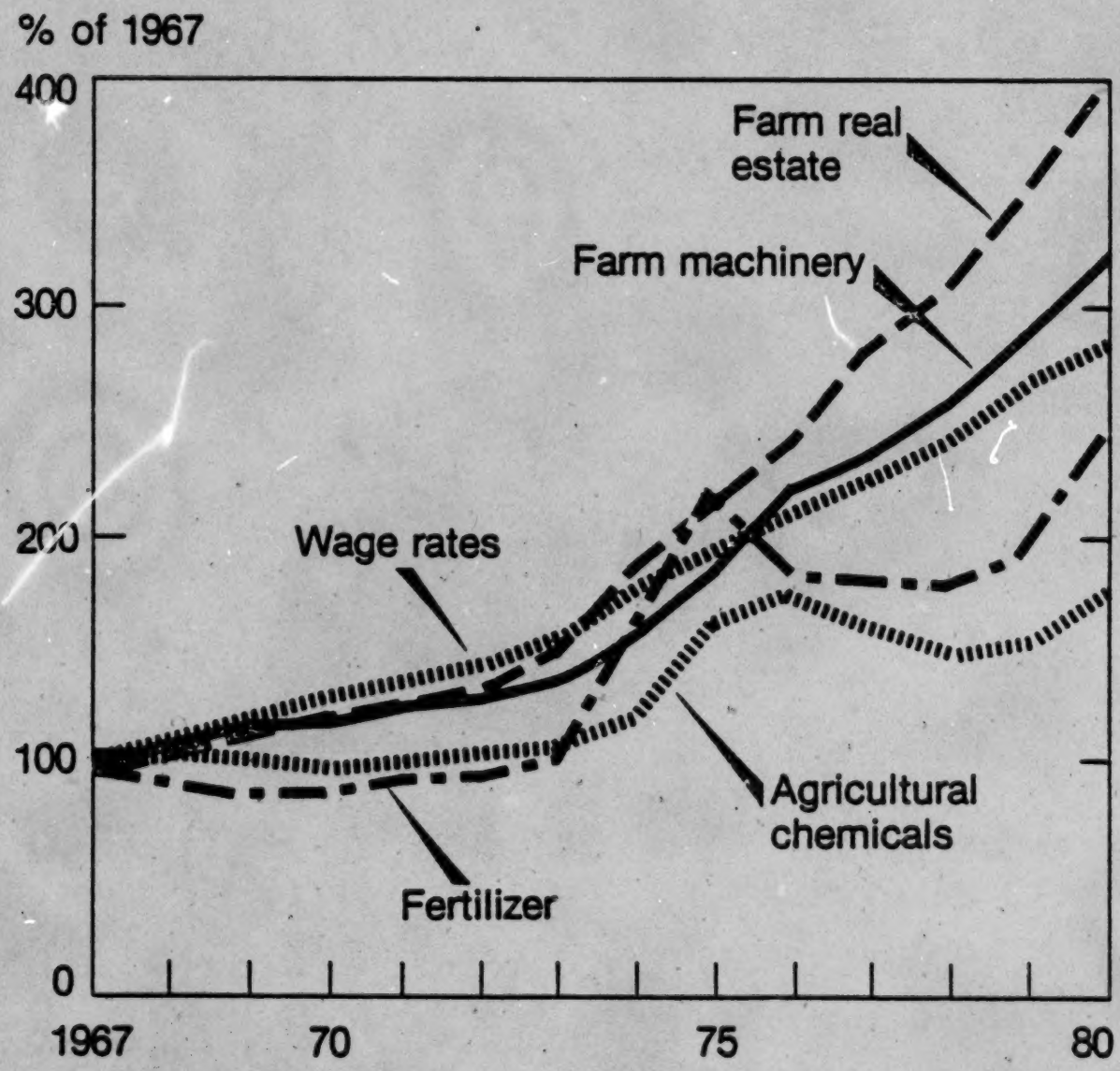


1975-77 data. Canada and United States include nonalcoholic beverages. West Germany includes alcoholic and nonalcoholic beverages.
Source: U.N. National Accounts of Statistics and National Sources.

Source: Handbook of Agricultural Charts, 1981.

109A-1-2

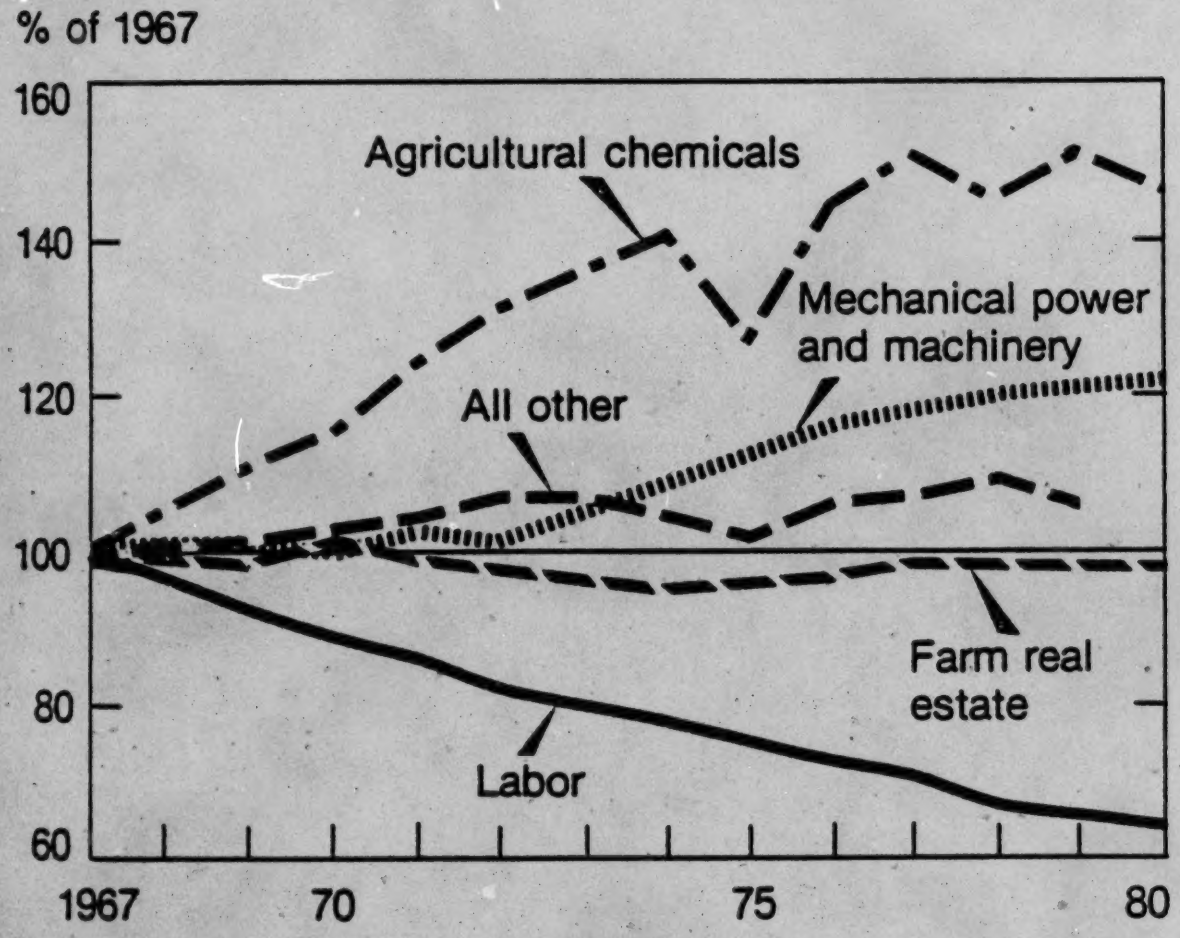
Prices of Selected Farm Inputs



Machinery includes tractors and self-propelled machinery. 1980 projected.

Source: Handbook of Agricultural Charts, 1981. 109A-1-3

Use of Selected Farm Inputs

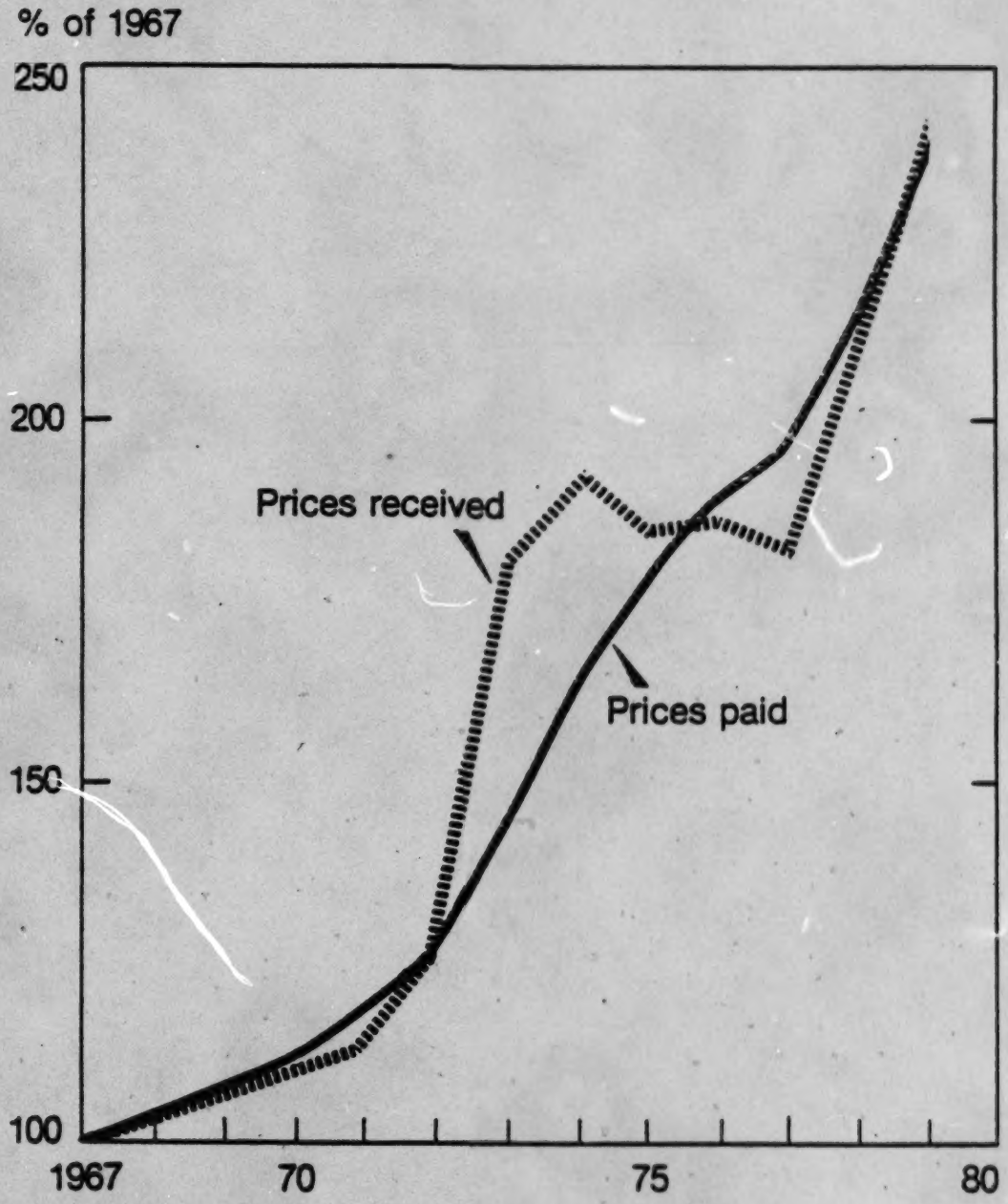


Data for All Other inputs not available for 1980.
1979 preliminary; 1980 estimated.

Source: Handbook of Agricultural Charts, 1981.

109A-1-4

Prices Received and Paid by Farmers



Prices paid includes commodities and services, interest, taxes, and wage rates.

Source: Handbook of Agricultural Charts, 1981.

109A-1-5

COMMON TERMS FOR CUSTOM APPLICATION OF PESTICIDES

ABSORPTION

The entrance of a chemical into a plant or microorganism.

ACARICIDE

A chemical used to kill mites (an insect relative) and ticks. Also known as miticide.

ACTIVE INGREDIENTS

The actual amount of pesticide present in the formulation.

ADJUVANT

An ingredient that improves the properties of a pesticide formulation; e.g., wetting agents, spreaders, emulsifiers, etc.

ADSORPTION

The binding of a chemical to the outside surface of small soil particles (soil colloids) or to plant parts.

AEROSOL

Colloidial suspension of a liquid or solid in air.

AGITATE

To keep a mixture stirred up.

AGROECOSYSTEM

An agricultural area sufficiently large to permit long-term interactions of all the living organisms and their nonliving environment.

ANNUAL WEEDS

Weeds that live one year and are propagated only by seed.

ANTIDOTE

A treatment used to counteract the effects of a poison.

APPLICATION RATE

Similar to dosage but more inclusive. For example: apply (name of chemical) at 1 pound actual chemical per acre in 10 gallons of water.

ATTRACTANT, INSECT

A substance that lures insects to trap or poison-bait locations.

AVICIDE

A substance to control pest birds. Generally not designed to kill, but to repel or to so affect a few individuals that others are frightened away.

AVOID

Don't do it. For example, "avoid spraying on windy days" means don't spray on windy days.

AVOID PROLONGED CONTACT

Do not allow spray to remain in contact with the skin, or do not breathe spray or fumes over a long period of time. Usually means hours.

BAND APPLICATION

Application as a band usually made over or beside a crop row.

BASAL APPLICATION

Application as a band directed at the base of a plant.

BIENNIAL (WEEDS)

Weeds that live for more than one year but not more than two years. First year - leaves and food; second year - fruit and seeds.

BIOLOGICAL CONTROL

Control of pests by means of living organisms; e.g., predators, parasites, and disease-producing organisms.

BLANKET APPLICATION

Application of a chemical over the entire area.

BROADCAST APPLICATION

Application made uniformly over an entire field.

BROAD-SPECTRUM INSECTICIDE

Nonselective, having nearly the same toxicity to most insects.

CARBAMATE INSECTICIDE

One of a class of insecticides derived from carbamic acid; e.g., carbaryl.

CARCINOGEN

A substance that will produce cancer.

CARRIER

Inert material, such as dust, clays, oils, water, and air, that is mixed with the pesticide and provides for more uniform dispersal of the pesticide.

CERTIFIED APPLICATOR

Commercial or private person qualified to apply restricted-use pesticides as defined by EPA.

CHEMOSTERILANT

A chemical used to sterilize or cause ineffective reproduction.

CHEMTREC

Toll-free number providing 24-hour emergency pesticide information (800-424-9300).

CHLORINATED HYDROCARBON INSECTICIDE

Synthetic compounds that contain hydrogen, carbon, and chlorine. They are persistent insecticides that kill insects mainly by contact action. They are insoluble in water and are decomposed by alkaline materials and high temperatures. Examples: DDT, aldrin, dieldrin, heptachlor, lindane, toxaphene, methoxychlor. Many of these have been banned because of their persistence in the food chain.

CHLOROSIS

When leaves turn yellow and lose their green color, either partially or completely.

COMBUSTIBLE

Will burn if near an open flame.

COMPATIBLE CHEMICALS

Chemicals that can be mixed together and still maintain a satisfactory physical state without decreasing their effectiveness against the intended pests.

CONCENTRATION

The amount of actual pesticide or active ingredient contained in a formulation or mixture to be applied.

CONTACT HERBICIDES

Herbicides that kill on contact. Example: paraquat.

CONTAMINATED

The presence of an unwanted pesticide or other material in or on plants, animals, soil, water, air, etc.

CROP TOLERANCE

The ability of a crop to be treated with a chemical without injury.

DEFOLIANT

A chemical which causes the leaves to drop from the plant.

DESICCANT

Material that cuts through or penetrates the skin of insects or the leaf surface of plants and causes their tissues to dry out.

DILUENT

Any material used to dilute a pesticide to the desired concentration.

DIRECTED APPLICATION

Implies application to a specific kind of plant or parts of a plant.

DISINFECTANT

A chemical or other agent that kills or inactivates disease-producing microorganisms. Also, refers to surface sterilization.

DORMANT PERIOD

Period of time in which seeds and other plant parts are not growing due to natural causes. (Example: apple trees in the winter)

DOSAGE

The amount of pesticide to be applied on a given area (e.g., an acre) or per unit of water.

DRIFT

Movement of material outside the intended target area during or shortly after application.

ECONOMIC LEVEL

The insect pest level at which additional management practices must be employed to prevent economic losses.

EDIBLE PARTS

Parts of a plant that are used for human or animal food.

EMETIC

Something that causes vomiting to get rid of poison in the stomach, an antidote.

EMULSIFIABLE CONCENTRATE

A liquid formulation containing a high amount of pesticide dissolved in a solvent together with an emulsifier. Designed to be mixed with water to the desired strength before being used.

EMULSIFIER

A chemical which helps keep one liquid mixed with another; one which mixes oil in water.

EMULSION

A mixture in which a pesticide in a liquid form (as minute globules) is suspended in water.

FIELD SCOUT

A person who samples fields for insect infestations, weeds, and other problems.

FORMULATION

The form in which the pesticide is offered for sale to the user, as emulsifiable concentrate, wettable powder, granules, dust, oil solution, etc.

FC (FULL COVERAGE)

The total amount of pesticide spray applied which will thoroughly cover the crop being treated to the point of runoff or drop.

FUMIGANT

A chemical which, as a gas, kills destructive animals and plants.

FUNGICIDE

A chemical used to kill fungi.

FUNGISTATS

A chemical which inhibits the growth of fungi.

GENERAL-USE PESTICIDES

A pesticide that can be purchased and used by the general public as long as label instructions are followed.

GRANULES

A formulation in which the pesticide is attached to particles of some inert carrier like clay or ground corn cobs. Size of most presently used granules is 15 to 40 mesh.

GROWTH REGULATOR

Organic substance used in small quantities to control or modify (plant or insect) growth processes.

HAZARD

The relative likelihood of ill effects or other danger.

HERBICIDE

A chemical used to kill or inhibit plant growth.

INCORPORATE INTO SOIL

To mix a herbicide or insecticide in the soil by mechanical means.

INFESTATION

An attack by insects; areas where insects are seen on the plant.

INGEST

To eat or swallow.

INHIBIT

To hamper or prevent seed from germinating or to stop plant growth.

INSECT-GROWTH REGULATOR

Chemical substance that disrupts the action of insect hormones.

INSECTICIDE

A chemical used to kill insects.

INTEGRATED PEST MANAGEMENT

Optimization of pest control in an economically and ecologically sound manner; balanced approach using mechanical, biological, and chemical control methods.

LABEL

A printed statement affixed to the pesticide container by the manufacturer listing the contents, directions for use, and precautions. A pesticide label must be approved and registered by the Federal EPA and the Division of Regulatory Services, College of Agriculture, University of Kentucky.

LARVA

The immature or worm stage (caterpillar, maggot, grub) of an insect which passes through 4 stages (egg, larva, pupa, adult) in its development.

LARVACIDE

An insecticide used to kill larvae of insects.

LC_{50} (Lethal Concentration--50)

Amount of pesticide in water or air required to kill 50% of a test organism population.

LD_{50} (Lethal Dosage--50)

Amount of pesticide taken orally or dermally required to kill 50% of a test organism population. Usually expressed in terms of milligrams of pesticide per kilogram of body weight of the test animal (mg/kg).

LV (LOW VOLUME)

Means that the total volume of the pesticide spray applied is adequate to uniformly cover the crop but not as a full-coverage spray to the point of runoff.

LVC (LOW VOLUME CONCENTRATE)

Refers to the pesticide formulation designed for "Ultra Low Volume" (ULV) applications. Usually a highly concentrated liquid formulation of a pesticide applied undiluted or with only a small amount of diluent added (usually an oil).

50-MESH SCREEN

Screens or strainers which have 50 holes per linear inch.

Mg/kg

Used to express the amount of pesticide in milligrams per kilogram of body weight to produce a desired effect. 1,000,000 milligrams = 1 kilogram = 2.2 pounds.

MISCIBLE

A substance that will mix with other substances (generally refers to liquids).

NEMATICIDE

A chemical that kills nematodes.

NEMATODE

Generally microscopic, unsegmented roundworms, usually living free in moist soil, water, or decaying matter or as parasites of plants and animals.

NOZZLE

A device for metering a spray solution.

NYMPH

The immature stage (resembling an adult) of an insect which passes through three stages (egg, nymph, adult) in its development.

ORGANIC PHOSPHORUS INSECTICIDE

A synthetic compound derived from phosphoric acid. Organic phosphorus insecticides are primarily contact killers with relatively short-lasting effects. They are decomposed by water and high temperature. Examples: malathion, parathion, diazinon, phorate, TEPP, dimethoate, etc.

ORIFICE

An opening in a nozzle tip, duster, or granular applicator through which the spray, dust, or granules flow.

OVICIDE

An insecticide used to kill the eggs of insects.

PARASITIC INSECT

An insect which lives in or on the body of another organism at the expense of the host.

PATHOGEN

An organism or agent capable of causing disease.

PERENNIAL WEED

A weed that lives for more than two years.

PESTICIDE

A chemical or mixture of chemicals used for controlling, preventing, destroying, repelling, or mitigating any pest.

PHEROMONES

Highly potent insect sex attractants; may be used for trapping.

PHYTOTOXIC

A chemical that is injurious or poisonous to plants.

POISON

A chemical causing a deleterious effect when absorbed, inhaled, or eaten by a living organism.

POSTEMERGENCE

Implies application of a chemical after emergence of the crop or weed.

ppb (PARTS PER BILLION)

Two crystals of sugar in 1,000 pounds, 1 ounce in 8,000,000 gallons, 1 inch in 16,000 miles.

ppm (PARTS PER MILLION)

Two crystals of sugar per pound, 1 ounce in 8,000 gallons, 1 inch in 16 miles.

PREDATORY OR PREDACEOUS INSECTS

Insects which feed on other insects.

PREEMERGENCE

Implies an application of a chemical before emergence of the crop.

PREPLANT TREATMENT

Treatment before planting.

PROPER DOSAGE

The right amount, according to label directions.

PROTECTANT

A chemical used to prevent infection or infestation by an organism.

PUPA

The resting stage of an insect which passes through four stages (egg, larva, pupa, adult) in its development.

REPELLENT

A chemical used to repel rather than kill an animal pest.

RESIDUAL

A characteristic of a pesticide to persist after application in amounts sufficient to kill pests, usually for several days to several weeks or even longer.

RESISTANT SPECIES

Pests that survive relatively high rates of application.

RESIDUE

Amount of pesticide present after application.

RESTRICTED-USE PESTICIDES

Pesticides designated by EPA that can be applied only by certified applicators for specific purposes.

RODENTICIDE

Pesticide applied to destroy or repel rodents and other animals.

RUNOFF

Pesticide material that is carried away from an area by flow of surface water. Also used to describe the rate of application to a surface, i.e., "spray to runoff."

SAFETY

The practical certainty that injury will not result from the proper use of a pesticide.

SELECTIVITY

Ability of a chemical to kill some pests but not affect others. Examples include selective herbicides and selective insecticides.

SIGNAL WORD

A required word that appears on every pesticide label to denote the relative toxicity of the product. Danger-poison for highly toxic; Warning for moderately toxic; or Caution for slightly toxic.

SOIL STERILANTS

Completely prevent growth of higher plant life.

SOIL STERILIZATION

Treating soil by heat or chemicals to kill living organisms.

SOLUBILITY

The maximum amount of a liquid or solid that will dissolve in a unit amount of liquid.

SOLUBLE POWDER

A powder formulation that dissolves and forms a solution in water or other liquid carrier.

SOLUTION

A mixture in which the pesticide is dissolved, in a liquid, usually in an oil solvent. The pesticide, as individual molecules, is evenly dispersed among the molecules of liquid.

SPOT TREATMENT

Application to a restricted or small area.

SURFACTANT

A material which reduces surface tension between two unlike materials such as oil and water. A spreader or wetting agent used to increase coverage of the surface being sprayed.

SUSPENSION

A mixture in which the pesticide in a solid form (tiny particles) is suspended in water.

SUSCEPTIBLE SPECIES

Pests readily killed by relatively low rates of chemical application.

SYMPTOMS

Responses of a plant or animal to the pest's activities.

SYNERGIST

A chemical that when mixed with a pesticide increases its toxicity. The synergist may or may not have pesticidal properties of its own.

SYSTEMIC (PESTICIDE)

One absorbed by treated plants or animals and translocated via their circulatory system to other tissues.

TENACITY

Tendency of a pesticide deposit to resist removal by weathering.

TOLERANCE

The amount of pesticide residue deemed safe and permitted by law on an agricultural product.

TOPICAL APPLICATION

Treatment of a localized surface site.

TOXIC

Poison that can kill or harm insects, animals, or humans.

TOXIC SYMPTOMS

Signs that tell if a person has been poisoned.

TOXICITY

Capacity of a pesticide to do harm.

TOXIN

A poison produced by a plant or animal.

TRANSLOCATED

An insecticide or herbicide which moves within the plant or animal. Example: from roots to leaves.

ULV (ULTRA LOW VOLUME)

Spraying by air or ground, an insecticide undiluted and in a very concentrated liquid form. Dose usually from 2 to 16 fluid ounces per acre, but always less than one-half gallon per acre.

VOLATILITY

The rate of evaporation of a chemical.

WETTABLE POWDER

A powder formulation containing a wetting agent that causes the powder to form a short-term suspension in water.

Lesson 2

USING AND HANDLING AGRICULTURAL PESTICIDES SAFELY

Objective -- To develop the ability of applicators to use and handle agricultural pesticides safely.

Problem and Analysis -- How can we use and handle pesticides safely?

- Individual responsibilities
- Safe pesticide usage
- Safe storage of pesticides
- Pesticide disposal

Content

I. Individual Responsibilities (Legal and Moral)

A. The Federal Insecticide Fungicide, and Rodenticide Act (FIFRA) was passed in 1947 and called for useful labelling on all pesticides. In 1972, FIFRA was amended by the Federal Environmental Pesticide Control Act.

B. This amendment called for pesticides to be classified as general use or restricted use categories. It also called for certification of pesticide applicators.

C. The Environmental Protection Agency is responsible for the registration of pesticides. One important part of the EPA regulations is the review process for pesticides. RPAR or Rebuttable Presumption Against Registration is the process used for review and public comment. Four stages of RPAR include:

1. Investigation of risk
2. Rebuttal of risk
3. Risk/Benefit Analysis
4. Review of outside recommendations

A particular chemical is nominated for review and examined for any of several "trigger" symptoms. Farmers can be involved in the RPAR process by providing written support for the suspect chemical and the impact upon the farming operation if the chemical is banned or limited in registration. Directions for citizen involvement are given in the Federal Register when an announcement is made of a chemical's review.

D. For assurance of continued pesticidal use, we must individually assume greater responsibility. Since it is demanded, now is the time to learn important facts on pesticide safety and use.

II. Safe Pesticide Usage

A. To fully understand the meaning of safe pesticide usage, we must explore the necessity for safe application. This has to be dealt with in terms of definitions and examples. Pesticides are toxic. Toxicity means the inherent capacity of a substance to produce injury or death in animals or humans. The toxicity of a pesticide is determined by the lethal dose (L.D.). LD/50 means the dosage or concentration of a chemical that will kill approximately 50% of the test animals in a certain length of time. The LD/50 varies depending upon the routes of absorption (oral, dermal, respiratory) and the percentage of active ingredient. Example: A material with only 50% active ingredient requires twice as much to produce a toxic effect as 100% pure material. Pesticides vary in the degree of toxicity class or rating. The lower the LD/50 value the greater the toxicity. The ranges and LD/50 oral rating, from highest to lowest, are:

	Oral dose for rats mg/kg	Probably lethal oral dose for man
1. Extremely toxic	Less than 5	A taste, a grain
2. Highly toxic	5-50	A pinch, 1 teaspoon
3. Moderately toxic	50-500	1 teaspoon to 2 tablespoons
4. Slightly toxic	500-5000	1 ounce to 1 pint
5. Practically non-toxic	5000-15000	1 pint to 1 quart
6. Relatively harmless	15,000+	1 quart

To translate the amount of LD/50 into the number of ounces that would be fatal to 50% of a group of men whose weight averaged 180 lbs., multiply mg/kg by 0.003 to get ounces per 180 lb. man. Example -- a chemical with a toxicity rating of 50 would require 50 x .003 = .15 oz.

B. Information about chemical toxicity to humans has been obtained from accidental exposures to harmful levels of chemicals, from suicides, and indirectly from tests on mice, rats, guinea pigs, poultry, dogs, and monkeys.

C. Safe transport of pesticides (from dealer to farm)

1. Due to certain restrictions, it has long been a practice that pesticide distributors, dealers, and retailers be cautious in the warehousing of pesticides where food and feedstuffs may be contaminated.

2. Purchasers of pesticides should not:

   a. Load pesticides with groceries and feed
   b. Carry pesticides inside car or truck cab due to possible spills or fumes from material volatilization

D. Reading the label

1. The label of a pesticide and the adherence to it are nearly priceless to the user in terms of proper use and safety.

2. Cost of pesticide development

   a. Before it can be sold, over two dozen research steps, 100,000 or more labor hours of testing, several years, and millions of dollars are needed to bring just one pesticide to market for man's use.
   b. In addition, the pesticide label has to be approved and registered by the Pesticide Regulations Division of the Federal EPA.

3. One of the following hazard warnings (signal words) will appear on a pesticide label:

   a. The word caution means the material is of low toxicity and hazard.
   b. The word warning means the material is of moderate toxicity and hazard.
   c. The words danger-poison on a pesticide label (printed in red and displaying a skull and crossbones) means the material is of high toxicity and hazard.
   d. These words -- caution, warning, and danger-poison -- dictate the type of protective clothing and/or devices one must use. A child hazard warning, "Keep Out of Reach of Children" must also appear on the label.

4. Important information concerning antidote(s) for the pesticides will also be found on the label as well as practical treatments.

E. Personal protective equipment

1. (See words caution, warning, and danger-poison under the section on Reading the Label.)

2. On pesticides identified as poison, all precautions on the label must be strictly followed. Since these pesticides are extremely poisonous, wear protective clothing and devices such as respirators and goggles at all times during mixing and application.

3. Shower or bathe as soon as the job is finished and put on clean clothes.

4. Do not smoke or eat while handling pesticides.

F. Safe mixing procedure

1. The greatest danger to the user is during preparation of pesticides for application. Care must be taken to prevent breathing the pesticide, getting it on your skin, or in your eyes.

2. In mixing highly toxic pesticides, have someone keep an eye on you for signs of toxic effect.

3. In mixing combinations of pesticides, be sure to check a spray-compatability chart.

G. Application procedures

1. You are the only one who can keep yourself safe when you are applying pesticides. Work safely. Know the danger of the pesticide you are using and how to keep yourself from being poisoned.

2. Temperatures during application can be a critical factor affecting results. Do not apply any fungicide or pesticide when temperature is above $85^{o}F$.

3. Use equipment that is in good working order and properly calibrated.

4. Avoid spraying stressed crops.

5. Do not apply more than the recommended amount of chemical; turning over sprayed ground, accidentally overlapping, or slowing down because of hills, are to be avoided.

6. Avoid spray drift.

H. Re-entry precautions

1. Regulations and restrictions on re-entry of fields following pesticide application are often written on the chemical label. Be sure to follow these directions.

I. Symptoms of pesticide poisoning

1. Symptoms of pesticide poisoning may resemble fatigue or other common conditions of illness. Specific signs of poisoning vary, depending on the pesticide involved. Generally, these include headache, blurred vision, nausea, cramps, diarrhea, chest discomfort, general numbness, or abnormal size of eye pupils.

2. Provide emergency first-aid for the victim, including rinsing the body, providing fresh air or artificial respiration, or other directions that are given on the label. Follow up this treatment with a visit to a physician.

3. Highly toxic pesticides have the antidote listed on the label. In case of poisoning, your doctor must know the antidote or active ingredient of the chemical in order to minister treatment. If directed to move the poisoning victim, take the label with you to the physician. However, don't carry the pesticide container in the passenger area of the vehicle.

III. Safe Storage of Pesticides

A. Improper storage increases the possibility of injury to children and livestock; keep storage locked.

B. Store pesticides in original containers; unmarked or improperly identified pesticide will undoubtedly be used for the wrong purpose.

C. Store pesticides only in an area set aside for this purpose. Do not store with food or feed or allow persons to sleep in these areas.

IV. Pesticide Disposal (involving empty containers, spills, and fires)

A. Check the product label of the manufacturer for procedures for safe disposal of empty containers.

B. In cleaning up spills, use protective equipment and devices as you would in mixing and applying.

C. To clean up spills:

1. If necessary, call for assistance to the emergency numbers listed on the master at the end of this lesson.

2. Use an absorbent cleaning compound such as clay, sawdust, or special products designed for this purpose.

3. Sweep and shovel contaminated material into a leakproof container and dispose of this by burying in the soil at least 18 inches deep in a special landfill. Check state and local regulations before burying in other locations.

4. Contact the appropriate police agency; highway patrol, county sheriff, or city police if the spill is on a street or road.

5. If water is contaminated, call county health officials.

D. Pesticide fires are very dangerous and hazardous and require the assistance of trained firemen. A list of stored pesticides should be filed with the local fire department.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:

1. Introductory statement -- As you may know by now, the federal government has banned uses of many chemicals in this country. They are being replaced by pesticides that have less long-term residual effect on the environment. Going to pesticides with a shorter-term residual, in many instances, requires the use of a more highly toxic pesticide, but this can be done safely by:

a. Realizing the importance of following all the safety practices in using the more toxic pesticides
b. Being well enough informed to assure safety to those people we may employ
c. Realizing pesticide safety has become one of our added responsibilities

2. Meaning of safety terms

3. Calculation of lethal dosage

B. Things to be brought out by class members:

1. Any information about chemical toxicity injury or death due to improper knowledge of safety

2. Any crops or livestock that failed to get marketed due to improper use of pesticides

II. Conclusions

A. Proper and safe use of pesticides has been and will continue to be a major responsibility.

B. A greater awareness of safety is needed due to individuals using and handling more toxic pesticides than in the past.

C. Store pesticides properly; store under lock and key, out of reach of children, pets, and livestock, and away from food and feed.

D. Disposal of empty pesticide containers, and taking care of spills are also very important and essential to safe use of pesticides.

III. Enrichment Activities

A. Have a fire department speaker or demonstration on control of chemical fires.

B. Provide each class member with a list of the poison control centers in Kentucky.

C. Analyze chemical labels.

IV. Suggested Teaching Materials

A. References for Lesson 2

- Apply Pesticides Correctly
- Applying Pesticides -- Management, Application, Safety
- Complete Guide to Pest Control
- The Pesticide Book
- The Pesticide Review Process

B. Resource personnel

1. Contact local fire department or health official.

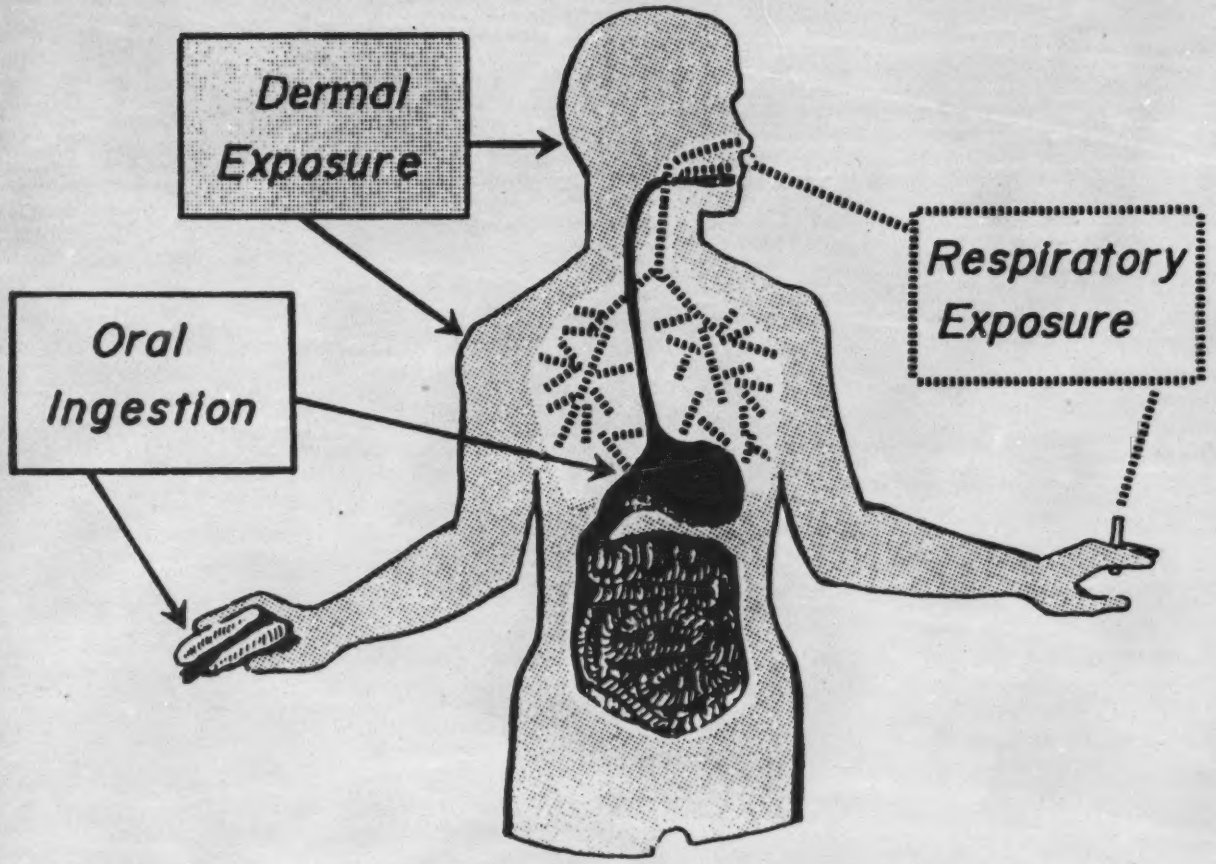
C. Audio-visuals

1. Masters

- Pesticides and the Human Body (Routes of Entry)
- Names, Classifications, and Toxicity of Insecticides
- Insecticides (Example of LD_{50} Values)
- Pesticide Emergency Telephone Numbers

PESTICIDES and the HUMAN BODY

ROUTES of ENTRY



NAMES, CLASSIFICATION AND TOXICITY OF INSECTICIDES

The following chart will help you to identify specific pesticides and give you an indication of their toxicities.

Names. Each generally used name of each pesticide is listed alphabetically in the left hand column of the chart. Synonyms in general usage are listed in the next column opposite each entry. Trade names are indicated by the superscript "*"; they should be capitalized. Other names are usually not capitalized.

Classes. Most insecticides are classified chemically as: OP = organic phosphates
CH = chlorinated hydrocarbons
Car. = carbamates

A few are of botanical or bacterial origin (B).

Toxicity Categories and LD_{50} Values. When registering pesticides, the Environmental Protection Agency uses acute LD_{50} values to determine the toxicity category and words or symbols that must be placed on the label. For this purpose, the test animals are usually rats, mice or rabbits but other mammals are sometimes used.

Toxicity Category	Signal Words Required On Label by EPA	ORAL LD_{50} (Mg./Kg.)	DERMAL LD_{50} (Mg./Kg.) 24-Hr. Exposure	Probable Lethal Oral Dose For Adult Humans
I. Highly Toxic	DANGER, POISON, Plus Skull & Crossbones Symbol	0 to 50	0 to 200 *	A few drops to 1 tsp.
II. Moderately Toxic	WARNING	>50 to 500	>200 to 2,000	1 tsp. to 2 Tbs.
III. Slightly Toxic	CAUTION	>500 to 5,000	>2,000 to 20,000	1 oz. to 1 pt. (1 lb.)
IV. Low Toxicity	CAUTION	>5,000	>20,000	1 pt. (1 lb.) or more

The LD_{50} is the dosage of the chemical at which one-half of the test animals are killed. It is based on the bodyweight of the animal and is expressed in milligrams of the chemical per kilogram of animal (mg./kg.). A mg./kg. is equivalent to 1 ppm. The lower the LD_{50} value, the higher the toxicity. Although most reported LD_{50} values are for technical material or actual toxicant, they are based on formulated products in some instances. All of these in the charts are for the technical material unless otherwise indicated. The toxicity categories given in the following charts are based on available data and are not necessarily the toxicity categories that would be assigned by EPA for the specific pesticides. Formulated pesticides usually have a higher LD_{50} than the technical material and may not fall in the same toxicity category as the technical material.

The usual ways of administering chemicals are oral (by mouth), dermal (applied to the skin) and inhalation. Inhalation toxicity is expressed as LC_{50} (lethal concentration). It is not as generally used as the other two.

Toxicity may be either acute or chronic. Acute refers to rather quick action from a single exposure, while chronic refers to the toxic effect of many exposures over a period of time.

SOURCE: 1981 Insect Management Recommendations For Field Crops and Livestock, p. 62, UK Cooperative Extension Service.

109A-2-2

INSECTICIDES
(Example of LD_{50} Values)

INSECTICIDE NAMES	OTHER NAMES	CLASS	TOXICITY CATEGORY	ACUTE LD_{50} VALUES FOR WHITE RATS ORAL (Mg./Kg.)	DERMAL (Mg./Kg.)
Abate*	Biothion*, tempophos	OP **	III	8600-13000	>4000
Acaraben*	chlorobenzilate, Akar*	CH †	III	960	
Acaralate*	chloropropylate	CH	III	5000 (2EC)	
acephate	Orthene*	OP	III	866-945	>2000 (rabbits)
Agritol*	Bacillus thuringiensis	B ††	IV	non-toxic to mammals	
Agritox*	trichloronate	OP	I	37.5	341
Akar*	chlorobenzilate, Acaraben*	CH	III	960	
Akton*	Axiom*	OP	I	146	177 (rabbits)
Alamos*	Azothoate*, Slam*	OP	II	>1500	>1500
aldicarb	Temik*	Car.†††	I	0.93	5.0 (rabbits)
aldrin		CH	I	39-60	98
allethrin	synthetic pyrethrins	Misc.	III	680-1000	>11200
aminocarb	Matacil*	Car.	I	50	>1000
Anthon*	trichlorfon, Dylox*, Dipterex*, Neguvon*	OP	III	560-630	>2000
arpocarb	Baygon*, propoxur	Car.	II	128	800-1000
Aspon*	NPD	OP	II	891-1700	
Axiom*	Akton*	OP	I	146	177 (rabbits)
Azinphos-ethyl	Ethyl Guthion*	OP	I	17.5	250
azinphosmethyl	Guthion*	OP	I	11-13	220
Azodrin*	monocrotophos	OP	I	17.5-20	112-126
Azothoate*	Alamos*, Slam*	OP	II	>1500	>1500
Bacillus thuringiensis	Biotrol*, Dipel*, Thuricide*, Agritol*	B	IV	non-toxic to mammals	
Baygon*	propoxur, arpocarb	Car.	II	128	800-1000
Baytex*	fenthion, Entex*	OP	II	215-245	330
Baythion*	phoxim	OP	III	1891-2077	>1126
Belt*	chlordane	CH	II	335-430	690-840
benzene hexa-chloride	BHC	CH	III	1250	
BHC	benzene hexachloride	CH	III	1250	
Bidrin*	dicrotophos	OP	I	22	225 (rabbits)
BINAPACRYL	Morocide*	Misc.	II	58-63	720-810
Biothion*	Abate*	OP	III	8600-13000	>4000
Biotrol*	Bacillus thuringiensis	B	IV	non-toxic to mammals	
Bladafume*	sulfotepp	OP	I	7-10	820 (rabbits)
Bolstar*	sulprofos	OP	II	107	20-31 (rabbits)
Bomyl*	Swat*	OP	I	32	400 (rabbits)
bufencarb	Bux*	Car.	II	87-170	400 (rabbits)
Bux*	bufencarb	Car.	II	87-170	>4000
carbaryl	Sevin*	Car.	III	500-850	>10200 (rabbits
carbofuran	Furadan*	Car.	I	11	27-54
carbophenothion	Trithion*	OP	I	10-30	>10200 (rabbits)
Carzol*	formetanate hydro-chloride	Car.	I	20	
chlorbenside	Chlorocide*	CH	III	>2000	
chlordane	Belt*	CH	II	335-430	690-840
chlordimeform	Fundal*, Galecron*, chlorophenamidine	Car.	II	250	4000 (rabbits)
chlorfenvinphos	Cpd 4072, Supona*	CH	I	12-56	31-108
chlorobenzilate	Acaraben*, Akar*	CH	III	960	
Chlorocide*	chlorbenside	CH	III	>2000	
chlorophena-midine	chlordimeform, Fundal*, Galecron*	Car.	II	250	4000 (rabbits
chlorpyrifos	Dursban*, Lorsban*	OP	II	97-276	2000 (rabbits)
chloropropylate	Acaralate*	CH	III	5000 (2EC)	
Chryson*	resmethrin, Synthrin*	B	III	1500	3040

SOURCE: 1981 Insect Management Recommendations For Field Crops and Livestock, p. 63, UK Cooperative Extension Service.

NOTE: This page is for illustrative purposes only. Many other insecticides are included on other pages in the Extension publication.

PESTICIDE EMERGENCY TELEPHONE NUMBERS

Pesticide Spills

If you have a pesticide spill and need information on how to handle this type of emergency, call:

CHEMTREC Pesticide Emergency Hotline (24 hour)

(800) 424-9300

Disaster Emergency Service (24 hour)
State Coordinating Agency for Disasters and Emergencies

(502) 564-7815

Division of Pesticides
Kentucky Department of Agriculture

(502) 564-7274

Kentucky Department of Human Resources

(502) 564-4537

Pesticide Exposures

If you have a person who has been exposed to a particular pesticide, provide your physician with the following emergency number which is designed to provide pharmacological information on pesticides to health professionals.

Pesticide Telecommunications Network (24 hour)

(800) 845-7633

SOURCE: 1981 Insect Management Recommendations For Field Crops and Livestock, p. 48, UK Cooperative Extension Service. 109A-2-4

Lesson 3

DEVELOPING A COMPREHENSIVE PEST CONTROL PROGRAM

Objective -- To develop the ability of applicators to develop a comprehensive pest control program.

Problem and Analysis -- What are the requirements for a good pest control program?

- Components of Integrated Pest Management

  1. Identifying pests
  2. Defining the management unit
  3. Developing a pest management strategy
  4. Developing monitoring techniques
  5. Establishing economic thresholds
  6. Developing descriptive and predictive models

- Practices to minimize pest problems
- Pesticide application equipment
- Selecting proper materials

Content

I. Components of Integrated Pest Management

A. Integrated Pest Management is the name given to a comprehensive approach to the pest management problem. It is a philosophy that embraces all possible economically and ecologically sound practices to optimize pest control. In the broadest sense, IPM considers all key pests in the crop production system, or in a narrow sense, concentrates on a single major pest. The program has a number of principles or components that are used in planning and implementing an IPM program.

1. Identify the pests to be controlled in the crop production system (agroecosystem). Weeds, insects, plant diseases, and nemotodes are all examples of possible pests. World-wide, this includes 30,000 species of weeds, 800,000 species of insects, 80,000 to 100,000 plant diseases, and 3,000 species of nematodes. Fortunately, only a percentage of each of these pest numbers are causes of serious economic problems. They are also further restricted to certain geographical locations and may affect only certain crops. However, a serious infestation of only one or more species of these pests may spell economic ruin for a producer or ultimately the consumer. Thus, identification is vital.

   IPM often relies upon the usage of trained field scouts. The scouts make routine checks of fields (usually weekly) to identify pest problems. The information is reported to the farmer or producer who makes the final decision on what course

of action to take, often using recommendations from the Cooperative Extension Service.

2. Define the management unit -- the agroecosystem. Agroecosystem is the term used to describe the relationship between the production unit (often a farm) and the environment. However, county-wide, state-wide, nation-wide, or continent-wide divisions may be appropriate for certain mobile pests. For the individual producer, decisions may be limited from a few to several thousand acres.

3. Develop the pest management strategy. Sufficient thought should be given by the producer to the control measures to be employed before the outbreak of a major pest problem. Biological, cultural, and mechanical controls should be utilized along with planting resistant varieties. This will allow the usage of chemical controls as the "Ace in the hole." Seldom will we be able to eradicate a pest, so one must opt for a containment strategy.

4. Develop reliable monitoring techniques. Information must be available to the producer on the concentrations of pests present and their stage of development. Scouts in IPM provide monitoring of crops for pests. This data through written reports, may cause the producer to immediately institute a control measure or plan measures for the next cropping season. While many producers attempt to monitor their own crops, often the task gets second priority behind other production chores. Also, individual farmers may not be able to compile a broad picture of the problem in a large area. Thus, a central headquarters for information gathering and analysis may be able to spot trends and problems before they occur.

5. Establish economic thresholds. Because the farmer cannot eradicate pest populations, he or she should determine the pest population level that causes economic losses to crops greater than the cost of implementing a pest control strategy. For example, how many alfalfa weevil larvae can be tolerated during the growing season before spraying must occur. Detailed information is available in the Kentucky Integrated Pest Management Scout Manual for alfalfa, corn, small grain, and soybean pests. However, this information will be further developed and refined over the next years as IPM progresses.

6. Develop descriptive and predictive models. With the increasing usage of computers to analyze data in minutes, rather than years, more sophisticated techniques will be applied to pest controls. Modeling will be helpful in predicting the behavior of insect pests as different strategies are implemented for control. While this may not be of immediate help to the individual producer, the long term results may be very satisfactory.

B. Integrated Pest Management has not been implemented on the wide-scale that was originally envisioned. This has resulted in part from a lack of coordination and funding as the concept moved from the Federal pilot project stage. However, progress is being made in establishing state programs.

II. Practices to minimize pest problems

Many techniques can be employed by the producer before resorting to the usage of pesticides. It is the wise use of these techniques, in combination with chemicals, that will provide the more comprehensive pest control program desired.

A. Natural control of pests

1. Weather, climate, and physical environment

2. Predators and parasites

3. Diseases

4. Food supply

B. Applied control measures

1. Biological control with predators and parasites

aa. this may involve artifically rearing and releasing native or exotic species

2. Biological control with microbes

aa. usage of bacteria and virus

3. Autocide (self-destruction)

aa. release of sterile insects using chemical sterilants
bb. genetic manipulation use of growth regulators

4. Developing pest-resistant plants

5. Physical and mechanical techniques

aa. screens or netting
bb. traps
cc. shields
dd. flooding
ee. applying heat or cold storage
ff. regulating humidity and moisture
gg. disinfecting seeds by aging

6. Cultural control practices

   aa. practicing good sanitation
   bb. timing of tillage practices
   cc. rotating crops
   dd. scheduling planting times
   ee. harvesting before damage occurs
   ff. selecting clean seed
   gg. removing hosts from nearby locations to crops

III. Pesticide Application Equipment

A. The job of the pesticide application equipment is to deliver the pesticide at proper rates to the area infested by the pest; ideally, for the most "kill" with the least amount of pesticide.

B. Proper use of the equipment is essential for efficiency of any dusting or spraying operation. In many cases, improper use of the equipment results in poor control of pests. Then too often the pesticides are blamed for the failure of the control program. In the case of insect control, the location of the pests on the plant determines how the equipment should be adjusted.

C. Specific information on pesticide application equipment will not be included in this unit. It is hoped that teachers will secure materials such as the AAVIM publication, Applying Pesticides, that contain equipment application information.

   It is further hoped that a more extensive treatment will be given to this topic in a future reference unit.

IV. Selecting Proper Materials

A. Only after the identity of the pest is known can we make proper selection of the materials to use. In most instances there is some leeway in the selection of materials to use. Pesticides are applied for one of two purposes:

   1. As a preventive measure.

   2. As a corrective or eradicative measure.

B. Factors that provide flexibility in selection of proper materials to use are:

   1. Toxicity variance (high to low LD_{50} materials)

   2. Formulations. In some instances wettable powders are safer to use on foliage applications.

   3. Residues. Proper selection of material can sometimes allow avoidance of persistent residues.

   4. Substitution of materials, to keep within allowable tolerance.

5. Combinations, to increase pest control effectiveness.

6. Selection of pesticides for specific or broad-spectrum control.

C. For assurance of selecting the proper material for the job, always check the pesticide label under Directions for Use.

D. Check the Cooperative Extension Service recommendations for proper material to use for a given pest problem.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:

1. The main areas of pest control programs that will be needed on the farm will be weed, insect and disease control.

2. Identifying weed, insects, and diseases is an essential part of a pest control program.

3. Any pest control program to be effective requires:

a. That materials be used at the right time
b. That materials be applied thoroughly

4. Provide good equipment to effectively and accurately distribute the pesticides.

5. The proper selection of pesticides is a must in order to secure good control.

B. Things to be brought out by the students:

1. Problems encountered in past pest control programs

2. Successes encountered in previous pest control programs

3. Problems encountered in positive pest identification

4. The need for greater skills in pest identification

II. Conclusions

A. Integrated Pest Management program participation should be considered by producers as it becomes available.

B. When individually unable to identify the pest problem, secure the help of a Cooperative Extension Service specialist.

C. Timeliness and thoroughness are essential components of a good pest control program, and this information is available from the label.

D. Good equipment is essential for proper distribution and applying the recommended rate of material.

E. The selection of proper material for the pest to be controlled is the key to pest control.

III. Enrichment Activities

A. Have on hand at meetings sample containers of herbicides, insecticides, fungicides secured from local dealer.

B. Have dealer bring in spray rig to show for inspection of group.

IV. Suggested Teaching Materials

A. References for Lesson 3

- Integrated Pest Management: A Program of Research ...
- Applying Pesticides

B. Resource personnel

1. Equipment dealers

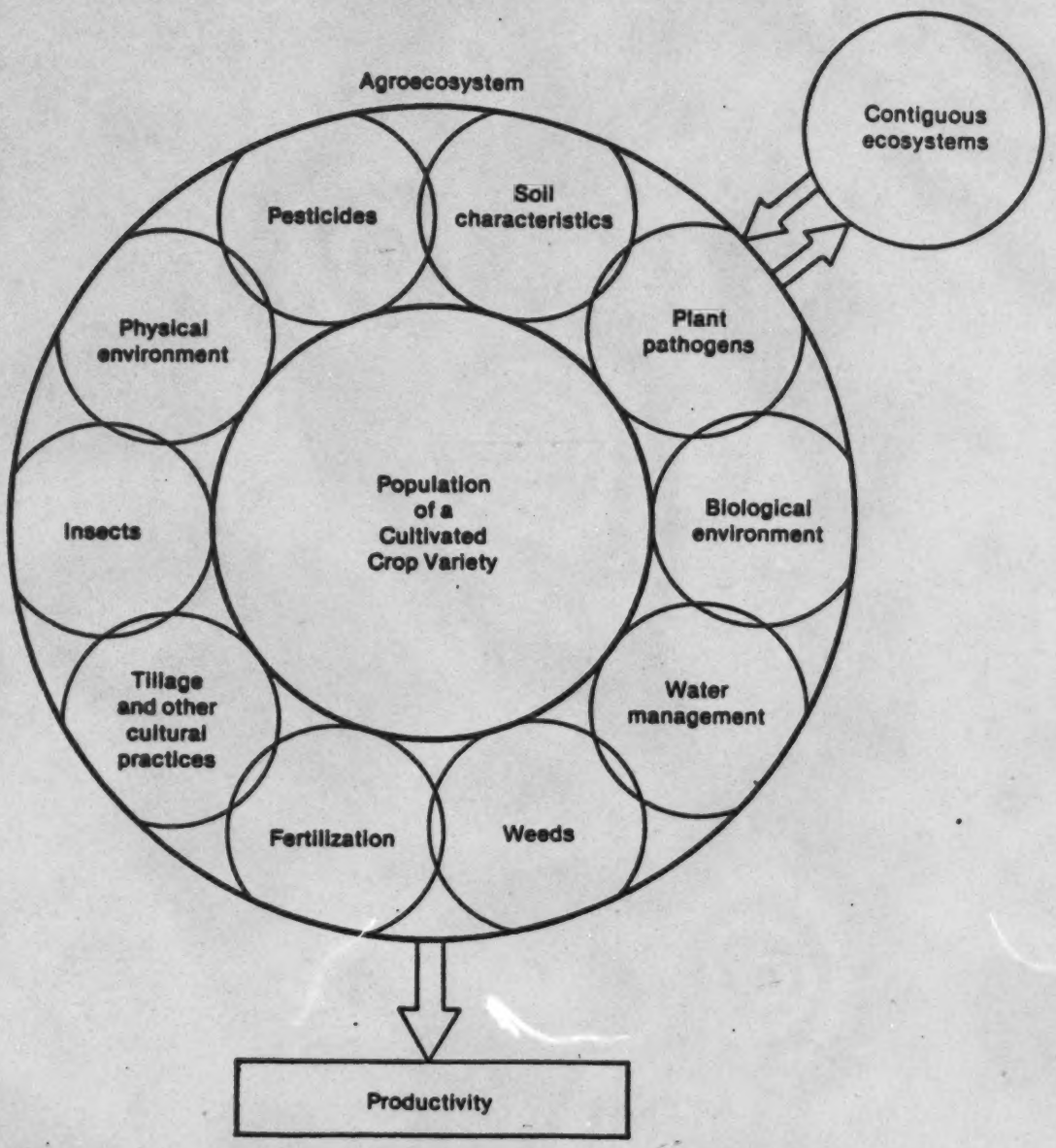
2. Custom applicators

C. Audio-visuals

1. Masters

- Diagrammatic Concept of an Agroecosystem
- Control Tactics ... Against Corn
- Control Tactics ... Against Soybeans

Figure 1.—Diagrammatic Concept of an Agroecosystem



SOURCE: J. L. Apple, "Impact of Plant Disease on World Food Production," pp. 39-49. In: D. Pimentel, ed., World Food, Pest Losses, and the Environment (Boulder, Colo: Westview Press, 1978).

Control Tactics Now Employed Against Major Pests of Corn in the Corn Belt

Native (N) / Introduced (I) Major pests	Biological		Host plant resistance	Cultural								Chemical			Other	
	Pred. & para.	Microbial		Sanitation	Eliminating hosts	Crop rot.	Planting date	Clean Seed	Water mgmt.	Fertility mgmt.	Tillage	Soil	Seed	Foliar	Monitoring	Predictive models
WEEDS																
Foxtail spp .....N	1	1	1	2	1	1	1	1	1	1	3	3	1	1	3	1
Pigweed I	1	1	1	2	1	1	1	1	1	1	3	3	1	3	3	1
Quack grass I	1	1	1	2	1	1	1	1	1	1	3	3	1	3	3	1
Lambsquarter I	1	1	1	2	1	1	1	1	1	1	3	3	1	3	3	1
Velvet leaf	1	1	1	2	1	1	1	1	1	1	3	3	1	3	3	1
Fall panicum	1	1	1	2	1	1	1	1	1	1	3	3	1	1	3	1
Barnyard grass I	1	1	1	2	1	1	1	1	1	1	3	3	1	1	3	1
Crabgrass	1	1	1	2	1	1	1	1	1	1	3	3	1	1	3	1
Yellow nutsedge I	1	1	1	2	1	1	1	1	2	1	3	3	1	1	3	1
Smartweed	1	1	1	2	1	1	0	1	2	1	3	3	1	3	3	1
ANTHROPODS																
Corn rootworms	1	1	1	1	3	3	2	1	2	2	1	3	1	2	2	2
Cutworms	1	1	1	1	3	2	3	1	2	2	1	3	1	3	1	1
European cornborers I	1	1	3	2	1	1	2	1	2	2	1	1	1	2	1	1
Army worms	1	1	1	2	1	1	1	1	2	2	1	2	0	3	1	1
Corn leaf aphid	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
Stored grain insects ...	1	1	1	3	1	1	1	1	1	1	1	1	3	1	1	1
DISEASES																
Seedling blight .....N	1	1	3	2	1	2	2	3	3	1	1	1	3	1		
Stalk rots .....N	1	1	3	2	1	3	2	1	3	3	2	1	1	1		
Anthracnose .....N	1	1	2	3	1	3	1	1	2	2	3	1	1	1		
Leaf blights .....N	1	1	3	2	1	1	1	1	2	2	1	1	1	1		
Bacterial wilt	1	1	3	3	1	2	2	1	1	1	1	1	1	1		
Smut .....N	1	1	3	2	1	1	1	1	1	1	1	1	1	1		
Ear rot .....N	1	1	3	2	1	2	1	1	1	2	1	1	1	1		
Viruses			3	2	3	2	3	1	1	1	3	1	1	1		

Key: 1 = little or no use
2 = some use
3 = major use

SOURCE: Pest Management Strategies in Crop Protection, Volume 1, p. 27.

Control Tactics Now Employed Against Major Pests of Soybean in the Southeast

Native (N) / Introduced (I)	Biological		Host plant resistance	Cultural								Chemical			Other	
	Pred. & para.	Microbial		Sanitation	Eliminating hosts	Crop rot.	Planting date	Clean Seed	Water mgmt.	Fertility mgmt.	Tillage	Soil	Seed	Foliar	Monitoring	Predictive models
WEEDS																
Cocklebur .....N	1	1	1	2	1	2	1	3	1	1	3	2	1	3	3	1
Sicklepod I	1	1	1	2	1	2	1	3	1	1	3	3	1	3	3	1
Morningglory I	1	1	1	2	1	2	1	3	1	1	3	2	1	3	3	1
Johnson grass I	1	1	1	2	1	2	1	3	1	1	3	3	1	2	1	1
Pigweed I	1	1	1	1	1	1	1	3	1	1	3	3	1	2	2	1
Crabgrass .....N	1	1	1	1	1	1	1	3	1	1	2	3	1	1	1	1
Prickly sida I	1	1	1	1	1	1	1	3	1	1	2	3	1	2	2	1
Hemp sesbania I	1	1	1	2	1	2	1	3	1	1	3	3	1	3	3	1
Florida pusley .....N	1	1	1	1	1	1	1	3	1	1	2	3	1	1	1	1
Nutsedges I	1	1	1	2	1	2	1	3	1	1	3	2	1	2	2	1
ANTHROPODS																
Bean leaf beetle*.....N	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1
Mexican bean beetle I	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1
Corn earworm*.....N	2	1	1	1	1	1	2	1	1	1	1	1	1	3	1	1
Soybean looper**.....N	2	2	1	1	1	1	1	1	1	1	1	1	1	3	1	1
Velvet bean caterpillar..N	2	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1
Southern green stink bug*.....I	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1
DISEASES																
Anthracnose .....N	1	1	1	1	1	2	1	2	1	1	1	1	2	3	1	3
Brown spot I	1	1	1	1	1	1	1	2	1	1	1	1	2	3	1	3
Frogeye I	1	1	2	1	1	1	1	2	1	1	1	1	1	3	1	2
Southern blight .....N	1	1	1	1	1	3	1	1	1	1	1	2	1	1	2	1
Pod and stem blight	1	1	1	1	1	2	1	2	1	2	1	1	3	2	1	2
Bacterial blight .....N	1	1	1	1	1	1	1	2	1	1	1	1	2	1	1	2
NEMATODES																
Root knot .....N	1	1	3	1	1	2	1	1	1	1	1	3	1	1	2	1
Soybean cyst I	1	1	3	1	1	3	1	3	1	1	1	2	1	1	1	1
Lesion .....N	1	1	1	1	1	2	1	1	1	1	1	3	1	1	1	1
Reniform I	1	1	2	1	1	2	1	1	1	1	1	3	1	1	1	1
Lance .....N	1	1	1	1	1	2	1	1	1	1	1	3	1	1	1	1
Ectoparasites.....N	1	1	1	1	1	2	1	1	1	1	1	3	1	1	1	1

*Trap crop control
**Migrate annually from central America and Carribean

Key: 1 = little or no use
2 = some use
3 = major use

SOURCE: Pest Management Strategies in Crop Protection, Volume 1, p. 33.

Lesson 4

UTILIZING HERBICIDES TO CONTROL WEEDS
IN THE COMMONLY GROWN CROPS

Objective -- To develop the ability of farmers to properly utilize herbicides in controlling weeds in the commonly grown crops.

Problem and Analysis -- How should we use herbicides in controlling weeds in the commonly grown crops?

- Need for good weed control
- Importance of weed identification
- Principles of chemical weed control
- Method and time of treatment
- Types of formulations
- Planning a complete weed control program based on recommendations

Content

I. Need for Good Weed Control

A. Advances in weed control. Modern weed control had its beginning with the introduction of 2,4-D in the early 1940's. By 1946, investigation showed that 2,4-D had been used on a few thousand acres. Other developments occurring very rapidly and influencing advances in weed control were:

1. Development of a low-volume sprayer and immediate mass production

2. Appearance of 2,4,5-T for brush control

3. Fast recognition by the chemical industry of a new potential market; consequently a surge in research and development

4. Steady drop in farm labor beginning after World War II

5. Continued acceptance of the need for good weed control by the producer

B. Advantages of herbicides as an economic farm management factor. Weeds are costly to agriculture producers. The economic advantages of chemical weed control can result from the following:

1. Labor savings (cultivation)

2. Lower equipment investment (in cultivating equipment)

3. Increase in crop yield due to reduced competition of weeds for plant nutrients and water

4. Better quality crops; increased market and feeding value

5. Increased land values where weed problems do not seem evident

6. Lower harvesting costs in weed-free crops

II. Importance of Proper Weed Identification

A. The method by which vegetation is controlled depends upon:

1. The length of life of the plant

2. The time of the year during which the plant grows

3. The methods of reproduction

B. Plants are divided into three general types according to their length of life: annuals, biennials, and perennials.

1. Annuals are a group of plants that complete their life cycle within one year. This means that, from the time of germination of the plant through growth and new seed production, the time is one year or less. Most common field weeds are annuals.
Examples: foxtails, pigweed, cocklebur, morning glory, panicum.

Annuals are sometimes classified as summer or winter annuals. Summer annuals are plants that come from seeds germinating in the spring. Winter annuals come from seeds germinating in the fall.

2. Biennials are a group of plants that live for more than one year, but not more than two. The seed production is generally accomplished the second year.
Examples: wild carrot, bullthistle, and burdock.

3. Perennials -- Both simple perennials and creeping perennials normally live for more than two years and reproduce by seed and/or vegetatively (creeping perennials).
Examples: Johnsongrass, quackgrass and Canadian thistle.

4. Seed laws in various states may classify weeds according to the difficulty of control (noxiousness) and limit the number of weed seed that may be present in seed for sale.

C. To maintain weed control and reduce weed populations of annuals and perennials we should (1) strive to eradicate perennial weeds and (2) keep down or eliminate sources of annual weed seeds. Practices that could be applied include:

1. Prevent seed formation of weeds, especially annuals and biennials since they reproduce only by seed.

2. Deplete the root food reserves of perennials by removing the upper part of the plant when root food reserves are at their lowest point.

3. Use cultural or mechanical weed control including tillage, mowing, mulching, hoeing, and even hand weed pulling under some conditions.

4. Use biological controls such as insects that feed on weeds.

5. Other cultural and biological controls include following approved practices in fertilizing, correcting soil pH, draining, planting thick populations at the right time, planting in rotation, using varieties that form dense leaf canopies, seeding "clean seed," killing weeds in pastures to prevent spread by livestock, and allowing manure to rot if large numbers of weed seeds are present.

III. Principles of Chemical Weed Control

A. How herbicides work. "Scientists Unlock Secrets of How Herbicides Work" was headlined in Agri-News, April, 1973. It was found that herbicides block an essential step in a plant's conversion of nitrogen into amino acids. Amino acids are so-called building blocks of protein and are essential to human and animal nutrition. Specifically, herbicides blocked nitrite (NO_2), a compound which the plant converts from the fertilizer form of nitrogen (NO_3), from completing its conversions to amino acids. In effect, herbicides disrupt this reaction and form an imaginary dam in the system causing a buildup of nitrites which eventually kill the plant.

B. Herbicide types

1. Selective herbicides are those which kill or damage some plants more than others. When applied at the recommended rate, selective herbicides usually control certain weeds with little or no injury to the crop.

a. Foliage applications are sprays applied to leaves of plants.

1) Contact herbicides are those that kill only the part of the plant covered by the chemical.
2) Translocated herbicides are those absorbed into the plant and translocated to other parts of the plant, both tops and roots.

b. Soil applications may be pre-plant, pre-emergence, or post-emergence. The herbicide may be applied before or after the weeds appear.

2. Non-selective herbicides are used when we intend to remove all or most of the plants within the treated area.

a. Foliage applications

1) Contact herbicides
2) Translocated herbicides

b. Soil applications

1) Fumigants
2) Sterilants

c. Aquatic applications are herbicides put into the water to control weed growth.

IV. Method and Time of Treatment

A. Herbicides may be applied as follows:

1. Pre-planting and incorporated -- into the soil before the crop is planted

2. Pre-emergence -- on the soil after planting, but before crops or weeds emerge

3. Post-transplanting -- on the soil after crop is transplanted, either before weeds emerge or after clean cultivation

4. Post-emergence -- on weeds after weeds and crops are up

5. Directed post-emergence -- on small weeds in rows of taller crops

B. Split application involves using two types of the above methods of application.
Example: A pre-planting incorporated herbicide followed by a pre-emergence herbicide at planting time.

C. Factors affecting herbicide selectivity when applied to foliage:

1. Retention. This is the amount of herbicide that remains on the foliage after application. This is affected by the kind of leaf the plant has; the kind of surface, shape, and position. Surfactants or other additives are often added to the herbicide to improve sticking ability.

2. Penetration or Absorption. In order for the killing action to take place, the herbicide must penetrate the leaf surface. Herbicides may enter through the cuticle, the stomato, or both. Thus, a knowledge of the herbicides rate of penetration through these structures is important. As temperature increases, the rate of penetration may increase. High humidity also aids absorption. Again, wetting agents are used to improve the effectiveness of herbicides.

3. Translocation. How herbicides move from one part of the plant to another is called translocation. Phloem, food transporting tissue, and xylem, water transporting tissue, are involved in this process. Rapidly growing plants receiving adequate amounts of moisture will help move herbicides within the plant best.

4. Metabolism. The biochemical process by which plants manufacture food materials and release energy. Herbicides may work on photosynthesis or respiration, the two processes of metabolism. Herbicides may upset metabolism through a number of ways. These are discussed more fully in Weed Control: Cultural and Chemical, pp. 51-52.

D. With soil applied herbicides, factors that influence selective action are:

1. Movement. Movement of herbicides within the soil is affected by the water solubility of the herbicide, amount of rainfall, soil texture, and organic matter.

2. Decomposition. The breakdown of a herbicide begins at the time of application. It is caused by volatilization, exposure to light and soil microorganisms, as well as chemical decomposition.

3. Adsorption. Adsorption is the clinging of a herbicide to a part of the soil. Organic matter levels, particle sizes, and moisture levels affect adsorption of herbicides.

4. Metabolism. See previous section for discussion.

E. Herbicide combinations. Tank-mix combination -- Herbicide combinations are being used more extensively. More will be available as experimental results show what the proper combinations are and label clearances can be obtained. Suitable tank-mix combinations are listed in AGR-6, Chemical Control of Weeds in Farm Crops in Kentucky - (current year). Some factors influencing the use of combinations are:

1. Broader spectrum weed control

2. Longer seasonal control
   Example: Fall panicum which has a late germinating date as compared to early grasses such as foxtail or most annual broadleaf weeds.

3. Give more consistent performance with different soil and weather conditions.

4. Reduced costs of application due to less trips across the field.

F. The role of agricultural spray adjuvants and surfactants is firmly established; these materials improve the efficiency of pesticide chemicals.

1. Definitions:

   a. An adjuvant is defined as an ingredient which, when added to a formulation, aids the action of the toxicant. The term includes such materials as wetting agents, spreaders, emulsifiers, dispersing agents, penetrants, and correctives.

b. A surfactant is a "surface active agent." Its primary function is that of aiding or enhancing the surface-modifying properties of a pesticide formulation (wetting agent, emulsifier, or spreader).

2. Functions of spray adjuvants -- A spray solution may have one or more functions to perform in order to provide a safe and effective application. These functions are primarily concerned with wetting the foliage and/or pest thoroughly and enhancing penetration.

V. Types of Formulations

A. Formulations. There are several forms in which a farmer may buy herbicides:

- Soluble liquid and solids
- Emulsifiable concentrates
- Wettable powders
- Flowables
- Granules

1. Soluble materials are the easiest of the herbicides to handle in a sprayer. Materials do not settle out and no agitation is required.

2. Emulsions are made up of one liquid dispersed in another liquid. Emulsifying agents keep the two liquids in suspension, but require slight agitation.

NOTE: Always roll cans or drums prior to tank mixing. These materials will settle out.

3. Wettable powders are finely ground particles designed to be suspended in water for application. Wettable powders do require good agitation from tank mixing until material is applied.

NOTE: In tank mixing, make a slurry mix in a smaller container before adding to a partially filled sprayer tank.

4. Flowables are pesticides that are soluble in neither oil or water. Rather than using an expensive solvent, the technical material is blended with a dust diluent and small amounts of water to form a pudding that can be sprayed. This mixture must be agitated.

5. Granules are a sprayed solution of the toxicant allowed to dry on carriers such as clay, sand, vermiculite or similar material and applied with a granule applicator.

VI. Planning a Complete Weed Control Program Based on Recommendations

A. Record keeping is essential in operating an efficient farm business. Keeping records of any pest control program should be an integral part of record keeping. Today it is a must in some specialized types of farming.
Examples: Fruit and vegetable production.

B. Planning weed-control programs for the following areas should be considered:

1. Controlling weeds within a specific crop

2. Controlling specific weed problems

3. Planning a weed-control program for the entire farm

4. Determining the best herbicides to use once other production practices are determined

C. Incorporate in the plans, recommendations of the Cooperative Extension Service.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:

1. For economical production of crops, the use of herbicides will continue to play an important role.

2. Weed identification is essential before the herbicide can be selected.

3. Herbicides are selective or non-selective in their mode of action.

4. The method and timing of application are critical to weed control.

5. Various formulations of herbicide compounds offer a degree of selectivity.

6. Planning and keeping records of weed control programs is good business.

B. Things to be brought out by class members:

1. Participation in use of weed survey form in identifying problem weeds on the farm

2. Success or failures in maintaining control of problem weeds

II. Conclusions

A. Herbicides are essential to competitively produce crops and improve the looks of our surroundings.

B. Weed identification is necessary in the selection of the proper herbicide.

C. Selecting a good herbicide type and formulation is important in controlling specific weed problems.

D. Method and time of treatment have much to do with the success of weed control.

E. In existing alternatives select the formulation that best fits the situation (i.e., provides control at the lowest level of environmental hazard).

F. A planned weed-control program will greatly aid good weed-control.

III. Enrichment Activities

A. Invite local Extension agent or Extension specialist to summarize experimental results of herbicide plot work nearest your area. (Interest runs very high in this topic.)

B. Herbicide Compatibility Chart -- note that many herbicides are of unknown compatibility.

IV. Suggested Teaching Materials

A. References for Lesson 4

- AGR-6, Chemical Control of Weeds ...
- Weed Control -- Cultural and Chemical

B. Resource personnel

1. Cooperative Extension specialists

2. Local sources

C. Audio-visuals

1. Masters

- Weeds Are Costly
- What Kind of Ammo
- A Complete Weed Control Program for the Farm
- Farm Survey of Problem Weeds
- Controlling Weeds Within a Specific Crop
- Controlling Specific Problem Weeds
- Planning a Weed Control Program
- Guide to Selecting the "Best" Herbicide

WEEDS ARE COSTLY

SOURCE: Weed Control, Cultural and Chemical, p. 2.

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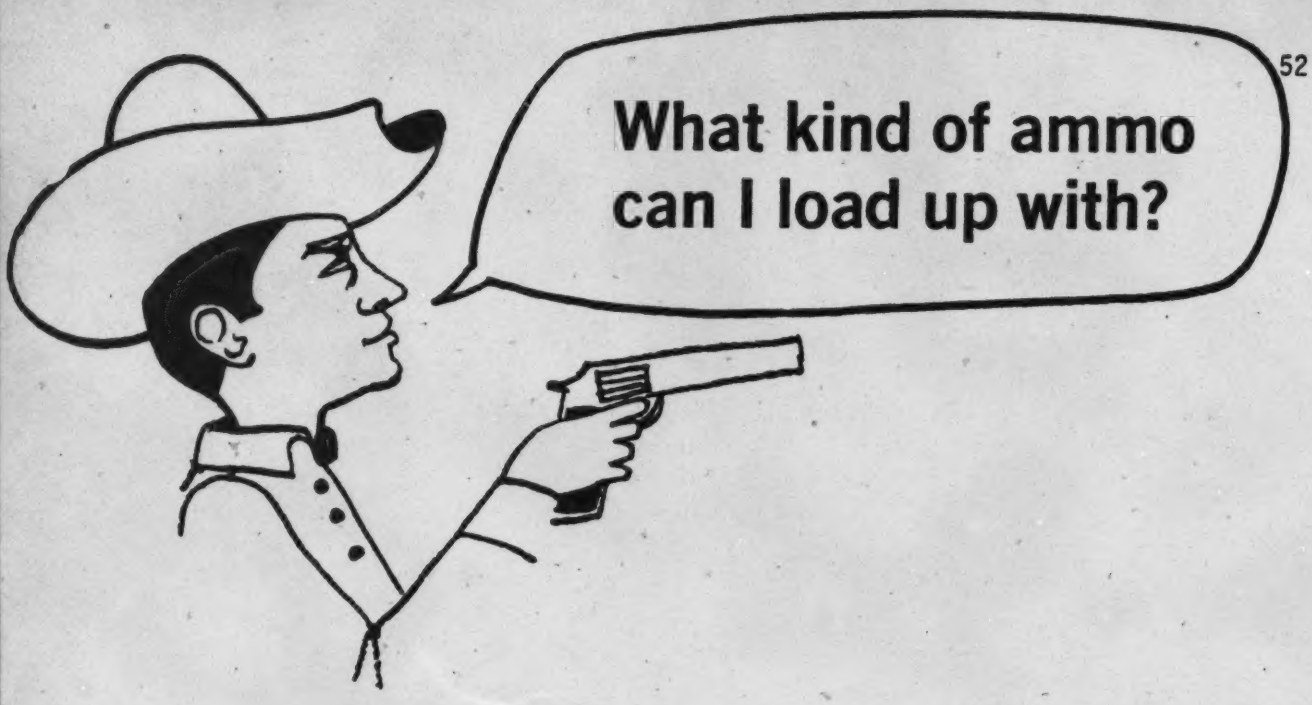
W.O. 1048-14



	CHEMICAL	or	TRADE NAME
1—	Atrazine		AAtrex
2—			
3—			
4—			
5—			
6—			

SOURCE: New Holland

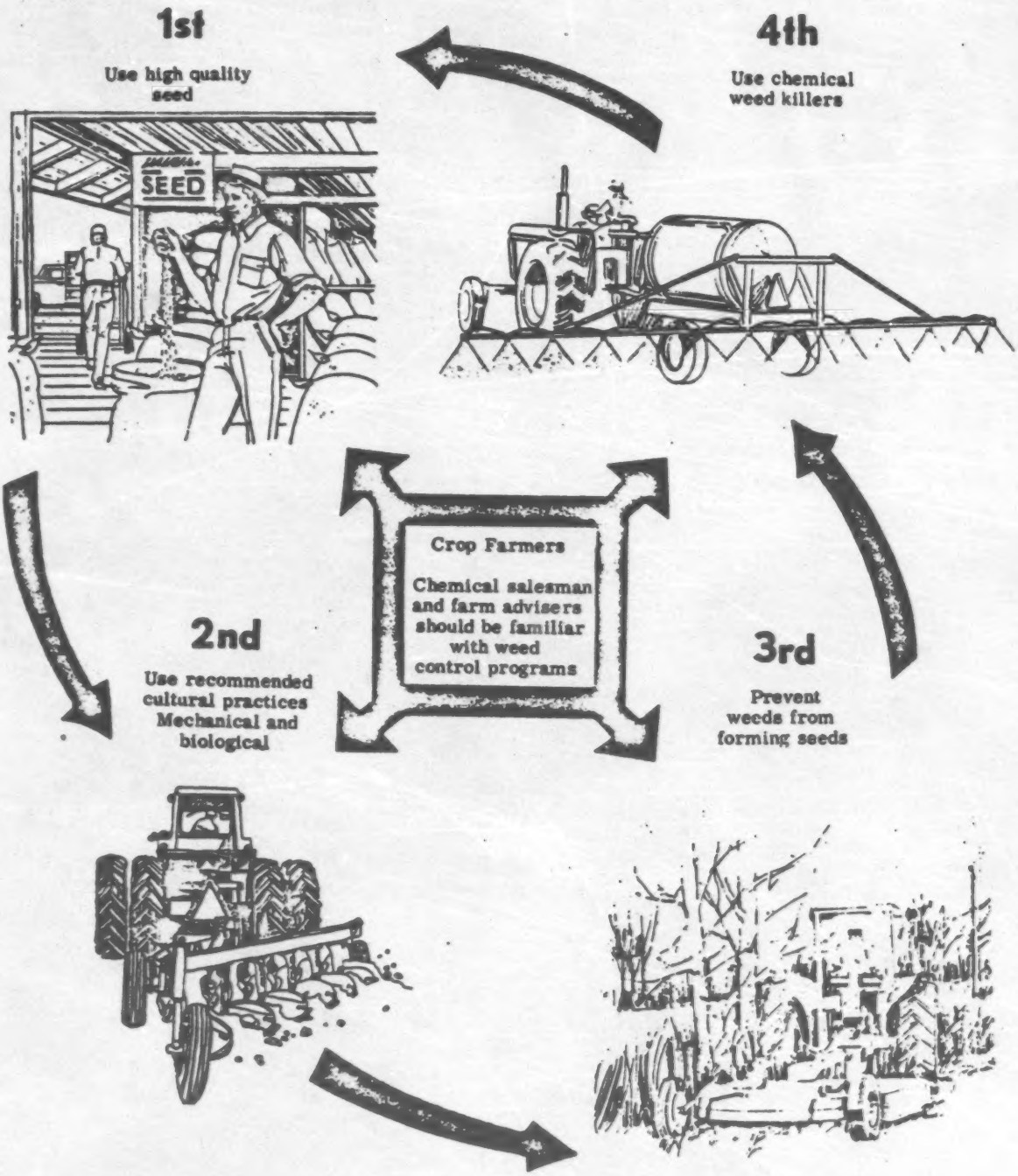


Figure 111. Each farmer should plan a complete weed control program for his farm.

Source: Weed Control, Cultural and Chemical, p. 95, Ohio Ag Ed Curriculum Materials Service.

FARM SURVEY OF PROBLEM WEEDS*

(Check each area where weeds are a problem)

Problem Weeds	Tobacco	Corn	Small Grains	Soy-beans	Other Locations								
					Hay Crops		Pasture Crops						
					Leg-umes	Grasses	Leg-umes	Grass	Fence Rows	Around Build-ings	Yard	Garden	Other
1.													
2.													
3.													
4.													
5.													
6.													
7.													
8.													
9.													
10.													
11.													
12.													

*Adapted from Weed Control, Cultural and Chemical (1st Edition), Ohio Ag Ed Curriculum Materials Service.

CONTROLLING WEEDS WITHIN A SPECIFIC CROP

Crop _____ **Principal Weeds to Control** _____

_____

CULTURAL METHODS

Machinery Required	Time to Use	Depth of Tillage	Speed	Soil Moisture Content			

BIOLOGICAL METHODS

Crop Rotation	Fertility Program	Soil pH	Quality of Seed	Time of Planting	Plant Population		

CHEMICAL METHODS

Herbicide(s)	Form of Herbicide	Rate	Soil Type and Organic Matter	Type of Application	Time of Application	Soil Incorporation	Effect on Following Crop

Source: Weed Control, Cultural and Chemical p. 97, Ohio Ag Ed Curriculum Materials Service.

109A-4-5

CONTROLLING SPECIFIC PROBLEM WEEDS

Specific Problem Weed Control _____

Growth Characteristics _____

CULTURAL METHODS

Weed Classification	How Reproduces and Spreads	Machinery Required	Timing of Operations	Follow-up Procedure	

BIOLOGICAL METHODS

Crop Rotation	Current Crop	Most Competitive Crop	Insects, Diseases Animals Used	

CHEMICAL METHODS

Herbicide(s)	Form of Herbicide	Rate	Soil Type and Organic Matter Content	Type of Application	Time of Application	Soil Incorporation	Effect on Following Crop

Source: Weed Control, Cultural and Chemical, p. 98, Ohio Ag Ed Curriculum Materials Service.

109A-4-6

PLANNING A WEED CONTROL PROGRAM

Name _____ Farm _____

Crops Raised	Problem Weeds	Control Methods					
		Cultural	Biological	Chemical			
		Method and Timing	Method and Timing	Name	Active Ingredients lbs./acre	Water gal./acre	Timing of Application

Source: Weed Control, Cultural and Chemical, p. 99, Ohio Ag Ed Curriculum Materials Service.

109A-4-7

GUIDE TO SELECTING THE "BEST" HERBICIDE

Crop_____

Weeds_____

Herbicides[1]

Considerations					
Cost per Acre					
Time & Method[2] of Application					
Number of Problem Weeds Controlled					
Length of Herbicide Residue					
Crops Affected by Herbicide Residue					
Period of Effectiveness					
Special Equipment Needed					
Other Considerations					

1 Note: Different forms and concentrations of each herbicide and different combinations of herbicides should also be considered.

2 e.g. Preplant incorporated, postemergence foliar, etc.

Lesson 5

UTILIZING INSECTICIDES IN THE COMMON ENTERPRISES

Objective: To develop the ability of farmers to properly utilize insecticides in controlling insects of commonly grown crops and livestock.

Problem and Analysis: How should we use insecticides in controlling insects in our commonly grown crops and livestock?

- Basic insect identification
- Insecticide types -- mode of action
- Insecticide classifications, formulations, residues, and tolerances
- Planning an insect control program for crops and livestock

Content

I. Basic Insect Identification

A. A brief review of insect classification consists of:

1. The first breakdown in classification of the animal kingdom is the phylum. The phylum of which insects are a part is called Arthropoda. This phylum is in turn broken down into five classes with insects being one of the classes. The class is further broken down into orders.

2. The class name given to insects is Insecta or Hexapoda (six legs). All insects during one or more of their life stages, depending on the species, have three pairs of legs.

3. The body of an insect is made up of three parts: the head, the thorax and the abdomen. These parts are most apparent in the adult stage. The eyes, antennae and mouth parts are in the head. The mouth parts, depending upon the species of insect, are adapted for chewing and sucking.

4. Insecta, or Hexapoda, is the class that is of major economic importance to agricultural production.

Orders and Families of Insects Important in Agriculture:

Insect Orders With No Metamorphosis

Collembola - Springtails
Thysanura - Silverfish, et. al.

Insect Orders With a Gradual or Incomplete Metamorphosis

Ephemeroptera - Mayflies
Odonata - Damselflies, dragonflies
Plecoptera - Stoneflies
Isoptera - Termites
Dermaptera - Earwigs
Psocoptera - Booklice, barklice
Thysanoptera - Thrips
Mallophaga - Chewing lice
Anoplura - Sucking lice
Orthoptera - Grasshoppers, crickets, cockroaches, et. al.
Hemiptera - True bugs
Homoptera - Aphids, cicadas, mealybugs, whiteflies, et. al.

Insect Orders With a Complete Metamorphosis

Coleoptera - Beetles, snout beetles, weevils
Lepidoptera - Moths, butterflies
Diptera - Flies, mosquitoes, midges
Hymenoptera - Sawflies, bees, wasps, ants, chalcids
Neuroptera - Lacewings, aphid lions, et. al.
Tricoptera - Caddiceflies
Mecoptera - Scorpionflies
Siphonaptera - Fleas

An excellent discussion with identifying pictures of these insects is contained in Chapter 4, "The Classification of Insects" in Fundamentals of Entomology and Plant Pathology.

5. Another class, Arachnida, order Acarina (ticks and mites), is also of economic importance. Adults have eight jointed legs and two body regions.

B. Insect life cycle

1. The life cycle of an insect is from the egg stage to the reproducing adult. The change in shape and appearance during the cycle is known as metamorphosis. There are four different life cycles of insects. They are:

   a. Without metamorphosis
   b. Gradual metamorphosis
   c. Incomplete metamorphosis
   d. Complete metamorphosis

2. Gradual metamorphosis and complete metamorphosis life cycles seem to more nearly apply to our insects that cause damage. The life cycle of the two are:

   a. Gradual metamorphosis -- the stages include the egg, nymph and the adult.
   b. Complete metamorphosis -- the stages include the egg, larva, pupa and adult.

3. Insect mouth parts

   a. Insects feed on plants and animals in two ways: chewing and sucking.

      1) Insects with chewing mouth parts obtain their food by biting off parts, e.g., roots, stems, fruit and foliage.
      2) Insects having sucking mouth parts obtain their food from plant sap or blood of animals.
      3) Modified types of sucking mouth parts:

         a) rasping-sucking (thrips)
         b) piercing-sucking (aphids, chinch bug, horseflies)
         c) sponging (order Diptera -- flies)
         d) siphoning (moths and butterflies)

   b. Many insect control methods are based on:

      1) The most vulnerable stage of metamorphosis
      2) Type of mouth parts of the insect

II. Insecticide Types and Mode of Action

   A. There are three major classifications of insecticides as to mode of action.

      1. Stomach insecticides must be swallowed by insects to be effective. Stomach insecticides are effective against insects with chewing mouth parts.

      2. Contact insecticides kill insects that touch, swallow, or breathe them. Contact insecticides are effective against insects that have the sucking type mouth, as well as those with chewing mouth parts. The insects must be present and contacted to be killed unless there is a residual contact effect.

      3. Fumigants kill insects in gaseous forms and require a type of enclosure. Fumigants are used in grain and soil fumigation.

   B. Systemic insecticides are primarily a stomach insecticide, but a few are also effective as contact insecticides. The principle action of the systemic insecticides is that the materials are absorbed into the plant tissue and the sap of the plant. The systemic insecticides are applied in the soil prior to or at planting time.

   C. Many insecticides serve a dual purpose in being used on both plants and animals. Example of dual purpose insecticide -- Malathion; label shows use for fruit crops, vegetable crops, alfalfa, and livestock.

D. Promising work has been completed with the usage of insect sexual attractants (pheromones). These substances aid in insect communication between individuals of the same species. Pheromones combined with traps have been successful in detecting and monitoring insect populations. They are not successful in eliminating a target pest, but in suppressing their numbers.

III. Insecticide Classification, Formulations, Residues and Tolerances

A. Insecticides or miticides can be classified in several ways:

1. By their persistence or ability to carry over residually (as residues on crops, in soil and environment)
2. By their usage as either preventive or corrective measures
3. By their chemical make-up
4. By their routes of entry into the target pest

B. Since chemical make-up (refer to A-3 above) is the most often used means of classification, these descriptions and examples are as follows:

1. Organochlorines -- chlorinated hydrocarbons. This group of pesticides contain carbon, chlorine, and hydrogen. The most famous of the organochlorines was DDT, discovered in 1939 and banned in 1973. DDT was banned because of the persistence in the environment and its accumulation in the food chain. Methoxychlor is also one of the organochlorines but it is readily metabolized. Most of the organochlorines have been replaced by less hazardous insecticides.

2. Cyclodienes -- The cyclodienes were developed after WW II and were extensively used as soil insecticides, termite controls, and for soil-borne insects whose larval stage feeds on the roots of plants. This group included chlordane, aldrin and dieldrin, heptachlor, endrin, and kepone. Structures treated for termites over 30 years ago are still protected--yet this persistency brought about the ban of the cyclodienes. They are also toxic to non-target pests and all aquatic life.

3. Organophosphates -- The organophosphates are derived from phosphoric acid and have varying combinations of oxygen, carbon, sulfur, and nitrogen attached to the phosphorus. They are related to the nerve gases of WW II and have largely replaced the organochlorines and cyclodienes because of their nonpersistence in the environment. Examples of organophosphates include diazinon, malathion, ronnel*, and disulfoton.

*Ronnel products will not be produced after available supplies are exhausted.

4. Organosulfurs -- These pesticides are used extensively for mite control as they have very low toxicity to insects. They will destroy the eggs as well as young and adult mites.

5. Organocarbamates -- These pesticides are derivatives of carbamic acid and act as stomach poisons, residual contact pesticides, and plant systemics. The group is readily degraded but is highly toxic to bees. Because of low mammalian oral and dermal toxicity and a broad spectrum of insect control, carbaryl is often used as a lawn and garden insecticide. Aldicarb and carbofuran are examples of other organocarbamates.

6. Formamidines -- These fairly new pesticides showed promise in treating pests resistant to the organophosphates and organocarbamates. They are used as ovicides, insecticides, and acaricides. However, some laboratory tests have shown them to possibly be carcinogenic. A very limited usage is permitted at the present time.

7. Thiocyanates -- These compounds have sulfur and cyanate molecules in their structured formulas. They are used for quick knockdown of flying insects and as soil fumigants.

8. Dinitrophenols -- The dinitrophenols have been greatly restricted in usage in later years. One was used as dormant sprays on fruit trees because of their toxicity to aphid eggs, some scale insects, and apple scab in fallen leaves.

9. Organotins -- This fairly new group may function as acaricides or fungicides or both. At present, three compounds are in use.

10. Botanical Insecticides -- Botanical insecticides are derived from plants or synthetic derivatives. Nicotine, pyrethrum, and rotenone are the three most useful botanicals. Rotenone is also used to kill fish in areas scheduled for restocking.

11. Halogenated Hydrocarbons -- Fumigants. Most fumigants, other than thiocyanates, are volatile, hydrogenated hydrocarbons with bromine, chlorine, or fluorine as the active ingredients.

    Fumigants are used as:

    1. Soil treatments
    2. Space treatments in home, industries, vehicles and storage facilities
    3. Space treatments in greenhouses or under coverings such as tarpaulins.

    Methyl bromide is a well known fumigant that by itself is odorless and colorless. Other warning gases are often added to eliminate accidental exposure to the gas. Fumigants work best at 75° - 85° F.

12. Petroleum Oils -- Oils used as pesticides are highly refined fractions of light lubricating petroleums. They are used to destroy mites and their eggs, mealybugs, certain scale insects, leafroller eggs, pear psyllids, and some other pests that overwinter on trees and shrubs.

13. Microbials -- This usage of fungi, bacteria, and viruses to attack insects is still largely in the experimental stages. Bacillus thuringiensis spores are available for caterpillar control.

C. Insecticides and miticides may be grouped by their method of application (formulations). Some of these formulations include:

1. Sprays

   a. Wettable powders -- These are dry forms of insecticide or miticide where the chemical ingredient is added to a carrier, such as clay, plus a wetting agent and ground to a powder-like fineness. Wettable powders form a suspension in water when stirred or agitated. Example: Sevin 50% WP.
   b. Soluble powders -- As the name indicates, these materials are dry powders that easily dissolve in water. Example: Orthene.
   c. Emulsifiable concentrates contain an organic solvent and emulsifier to facilitate mixing with water. Example: Malathion 57% EC, Diazinon EC.
   d. Flowable materials are concentrated pesticides formulated in a paste-like pudding. These disperse rapidly in water. Examples: Sevin flowable, Furadan 4 flowable.

2. Dusts -- Pesticide dusts are most often made with talcs, pryophyllite, clays, calcium carbonate, forms of silicates, diatomaceous earth, ground plant materials (tobacco dust, walnut shell) as the diluent materials. Most insecticides can be compounded as dusts. Example: Sevin 10% dust.

3. Granules -- These are formulated like dusts, but are composed of heavier and larger particles that fall readily upon application. Granular formulations are primarily for soil treatments. Example: Di-Syston 15% G.

4. Aerosols -- A system of particles dispersed in a gas. Liquid particles make up a fog. For liquified-gas aerosols, the toxicant is dissolved in a low boiling liquid and held under a pressure in a metal cylinder. When a valve is opened, a fine spray is ejected, the propellant liquid is quickly vaporized and the active ingredient remains suspended in the air. Example: "Bug" bombs.

5. Fumigants -- A substance or mixture of substances which produce gas, vapor, fume or smoke intended to destroy insects, bacteria or rodents. Used in confined areas such as soil treatment, grain storage, warehouse, etc. Example: Methyl bromide as a soil fumigant.

D. Insecticides and miticides can be grouped according to their route of entry and pest selectivity.

E. Insecticides and miticides are usually applied for one or two principal purposes:

1. As a preventive measure -- The chemical is applied on the crop, or soil, before the pest appears in damaging numbers.

2. As a corrective treatment -- Chemicals that kill most pests present or at least reduce their number below the economics threshold of damage. (The economic threshold level of a pest is the level above which economic loss is caused by the pest.)

F. Residues of pesticides -- The long-lived materials are the ones that have us in environmental difficulties today. The term "residue" means that quantity of a substance, especially of active pesticide, remaining on or in a surface or crop (including livestock products). Many degrees of persistency exist, often as a necessary attribute. Example: A contact insecticide must remain on the insect long enough to take effect. Those chlorinated hydrocarbon insecticides such as Dieldrin are much more persistent than organic phosphorous insecticides. Persistency is dependent upon such properties as volatility and resistance to breakdown.

G. Tolerances -- The tolerance for a pesticide is:

1. Under the "Miller Pesticide Residue Amendment" to the Federal Food, Drug and Cosmetic Act, the minute trace permitted by the F.D.A. to be present in or on raw agricultural commodities.

2. Under the "Food Additive Amendment," the trace permitted in or on processed or semi-processed food or feed products.

NOTE: Follow strictly the cutoff date as recommended on the label or spray guide.

IV. Planning an Insect Control Program Based on Recommendations for Crops and Livestock

A. Keeping records of insect and mite control, just like a herbicide control program, should be an integral part of record keeping.

B. A grower's insecticide application record will likely be required by law, especially for those growers hiring employees.

C. The insecticide and miticide control program should include the following features.

1. Select the safest material possible
2. Select a material that will be effective
3. Select materials that are not long-lived residuals, when possible

D. Incorporate in the control program recommendations of the Cooperative Extension Service.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:

1. In usage of pesticides, insecticides follow closely behind that of herbicides.

2. In the lesson on the requirements of a good pest control program, the same requirements apply to the insecticide control program that are stated in the lesson on the requirements of a good pest control program.

3. Greater emphasis needs to be placed on safety, since many of the insecticides are far more toxic than some of the other pesticides.

4. Insect identification is essential from the standpoint of being able to determine whether the insect causing the damage has chewing or sucking mouth parts, and the stage(s) of the life cycle during which the damage is done: larva, adult, etc.

5. The selection of insecticide type as to its mode of action can be a decisive factor in good insect control.

6. The organophosphate insecticides (short-lived residuals) are being used with increasing frequency to replace the more persistent (long-lived residuals) chlorinated hydrocarbon insecticides, many of which have been banned. The organophosphates as a group are more toxic and pose a greater potential health hazard to the user. If properly used, they are safe.

7. Planning and keeping records of the insecticide control program is good business.

B. Things to be brought out by class members:

1. What insect pests have given the most trouble in the last year? What areas have they occurred in? Livestock: beef, dairy, hogs, etc.; crops: corn, soybeans, forage crops and tobacco.

2. Successes and/or failures in insect control.

II. Conclusions

A. Insecticide use is important in producing many of the crops and securing good livestock production.

B. To get good insect control, we need to identify the insect pest.

C. It is important to select the right insecticide type to properly control the insect.

D. Select an effective insecticide having the least safety hazard.

E. Select a formulation of insecticide that best fits the need to obtain control of insects.

F. Select insecticides that have the shortest-lived residual effect, yet are long enough to get good insect control.

G. Check manufacturer's label or recommendations for cutoff date to stay within accepted tolerances of residues on the raw agricultural product.

H. Keep grower insecticide records.

III. Enrichment Activities

A. Invite local extension agent or extension specialist in to summarize experimental results of insect control plot work nearest your area.

B. Tour experimental plots (in season).

IV. Suggested Teaching Materials

A. References for Lesson 5

- Fundamentals of Entomology and Plant Pathology
- The Pesticide Book

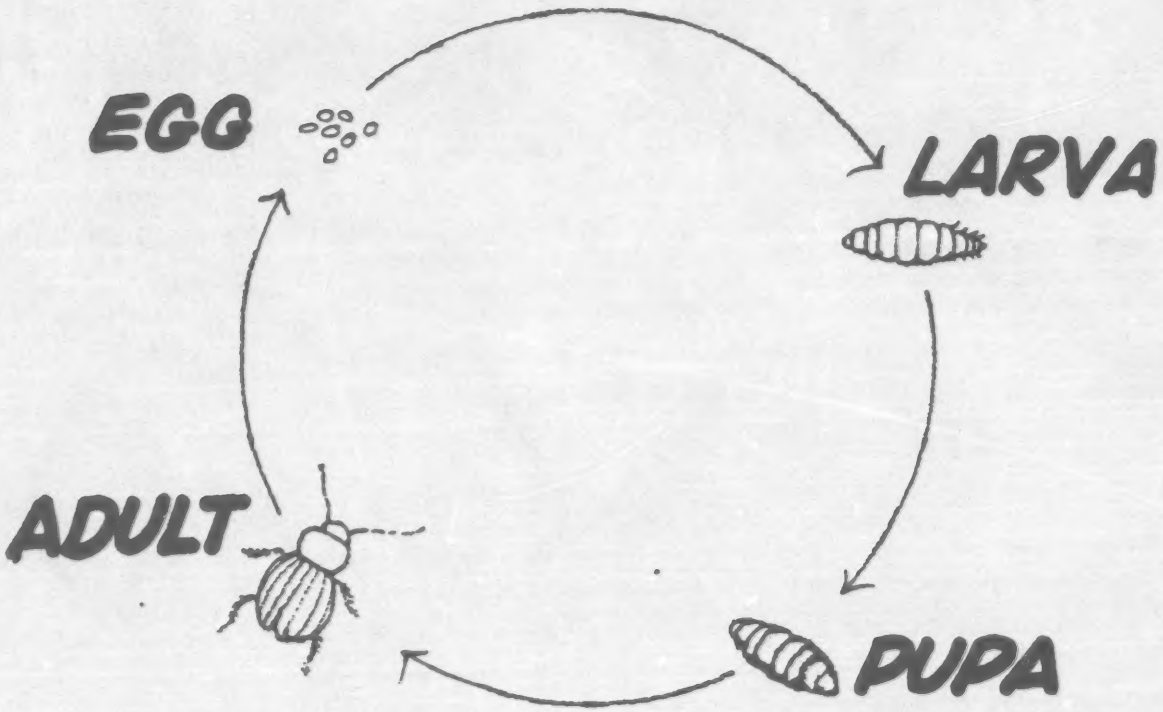
B. Resource Personnel

- Local sources

C. Audio-Visuals

- Life Cycle of Insects
- Grower's Pesticide Application Record
- Body Parts of Grasshopper
- Class Member's Chart of Harmful Insects

LIFE CYCLE OF INSECTS



SOURCE: New Holland

109A-5-1

GROWER'S PESTICIDE APPLICATION RECORD

Grower's Name ..... Crop and Variety .....

DATE OF APPLICATION	NAME OF AREA TREATED (Description)	DATE OF PLANTING OR STAGE OF GROWTH	PESTS CONTROLLED	MATERIALS USED AND HOW APPLIED	AMOUNT MATERIAL USED	AREA COVERED (Acres or Cu. Ft.)	WEATHER CONDITIONS

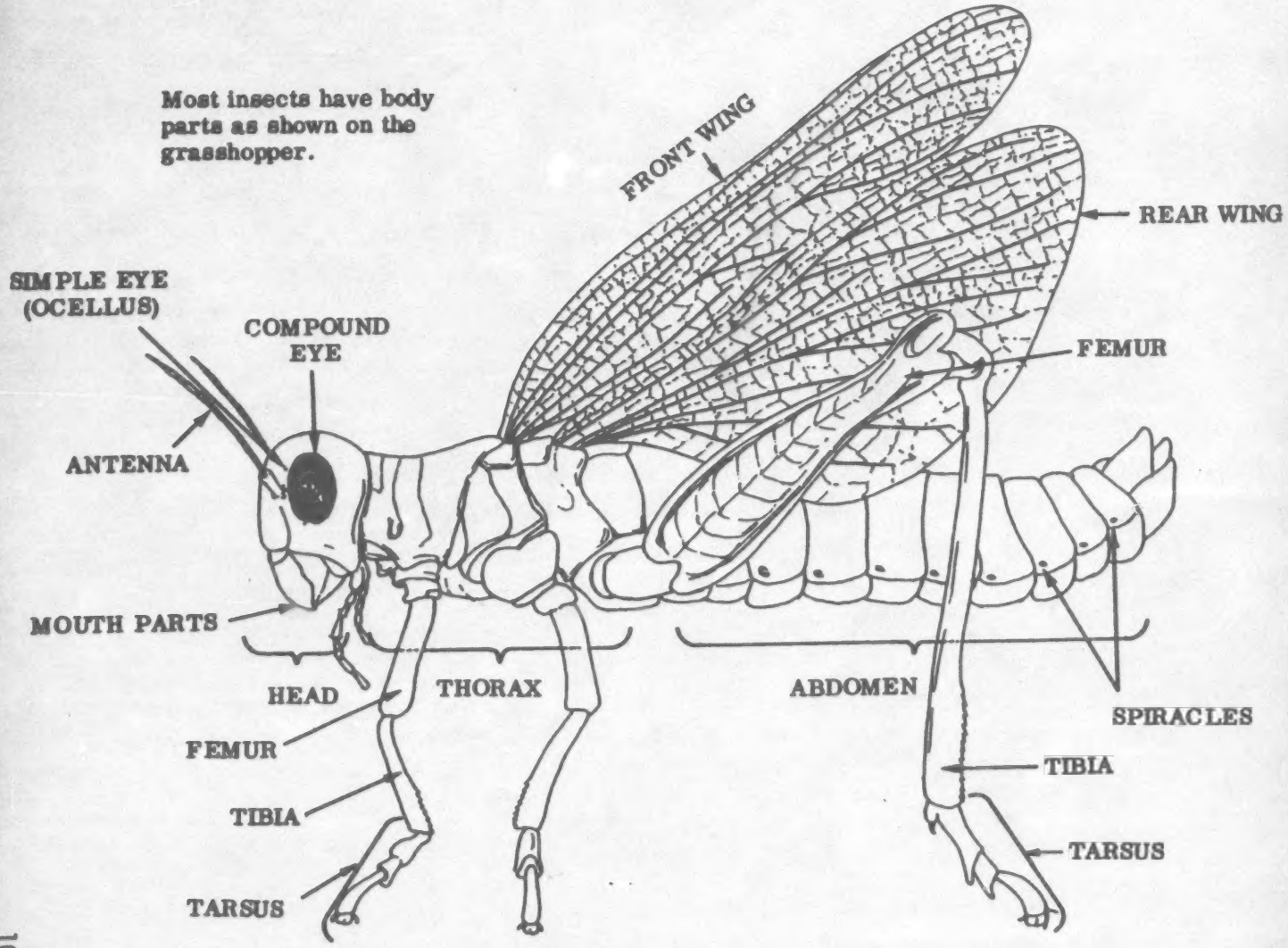
Physician's Phone No.

Use Pesticides Only: —on crop specified, —at time specified, —at rate specified

109A-5-2

W.O. 1048-20

Most insects have body parts as shown on the grasshopper.



SOURCE: Some Common Types of Insects, Ohio Agricultural Education Service, p. 8.

109A-5-3

Class Member's Chart of Harmful Insects

Name of Harmful Insect	Crop or Crops Damaged	Type of Damage	Livestock Attacked	Type of Damage	Prevention or Control

SOURCE: Some Common Types of Insects, Ohio Agricultural Education Service, p. 4.

Lesson 6

UTILIZING FUNGICIDES IN PLANT-DISEASE CONTROL

Objective -- To develop the ability of farmers to properly utilize fungicides in plant disease control.

Problem and Analysis -- How should we use fungicides in plant disease control?

- Basic plant-disease identification
- Principles of plant-disease control
- Types of fungicides by general use
- Fungicide classification by chemical group
- Planning a disease-control program

Content

I. Basic Plant Disease Identification

A. The Great Plant Groups -- Three major divisions of the plant kingdom are recognized. These are the Thallophytes, the Bryophytes, and the vascular plants or Tracheophytes. It is mainly the Thallophyte group that we are concerned with here. There are two main series of Thallophytes:

1. The algae possess the green pigment chlorophyll and are able to manufacture their own food; they include all the seaweeds and their fresh water allies. Examples: pond scum, simple green algae of salt and fresh water, brown algae and red algae (almost entirely confined to the sea).

2. The fungi lack chlorophyll and secure their food from living animals, plants, and dead organic materials.

a. To this group belongs the vast array of bacteria, molds, mildews, blights, rusts, toadstools, mushrooms, and similar plants. This series of Thallophytes is saprophytic (living on dead organic matter) and/or parasitic (living on or within another living animal or plant).
b. It is the fungi and the fungi-disease producers with which we are mainly concerned in crop disease prevention and control.
c. Fungi reproduce both asexually and sexually.

B. Although no attempt is made here to spell out detailed disease descriptions, the key to preventing loss to plant disease is prompt and correct diagnosis of the problem. Only at this point can proper control measures be applied.

C. In many instances, identifying plant diseases will require the services of a plant pathologist.

D. Where positive plant disease identification is not readily available, the following analysis is suggested as preliminary steps to take:

1. When to suspect disease -- One of the four main types of plant disease symptoms would be cause for suspicion of disease involvement:

aa. dying or death of cells, tissues, or organs (necrotic symptoms
bb. loss, suppression, or reduction of normal green color (chlorotic symptoms)
cc. underdevelopment of or stopping of growth of cells, tissues, or organs (hypoplastic symptoms)
dd. overdevelopment of cells, tissues, or organs (hyperplastic symptoms)

2. Counterchecks to be sure disease is involved and not symptoms from other causes:

a. Check poor plant adaptation to area.
b. Could the damage have been caused by other means such as insects, pets, or children?
c. Were the plants growing in poorly drained soil, or poor physical soil conditions for root development?
d. Could the damage have been caused by: excessive rainfall, high winds, hail, etc.; mechanical damage due to tillage equipment; or industrial air pollutants?
e. Did the unhealthy plants receive different treatment than the healthy ones?
f. Do different types of plants nearby have the same symptoms? (If so, chances are that plant disease is not involved.)

3. After determining that other symptom-causing conditions are not responsible for the plant's condition, an attempt can be made to personally diagnose the disease through study of the symptoms. If you still cannot identify the trouble, select a specimen and send it to the Extension Plant Pathologist for disease identification. The local Agricultural Extension Agent will forward the specimen, upon request.

II. Principles of Plant Disease Control

A. Definition of plant disease and its features -- Numerous definitions of plant disease exist, although one has been commonly accepted: A plant disease is any condition in which a plant is different in some way from a normal (i.e., healthy) plant in either structure or function. To prove that a disease is caused by a particular organism, the following four postulates (Koch's) may be applied:

1. The organism should be associated with all cases of a given disease.

2. The organism must be isolated from the diseased plant.

3. When the organism is inoculated into susceptible plants, it must reproduce the disease.

4. The organism must be re-isolated from the experimental infection.

B. Causes of plant disease:

1. The agent causing a plant disease is called a plant pathogene.

2. Pathogenes are divided into three distinct groups.

a. living organisms
b. viruses
c. physiopaths (non-living factors)
Examples of each are:

Living	Viruses	Physiopaths
bacteria	- listed under common names with no standard classification yet	improper environmental, nutritional, or physical conditions
fungi		
nematode worms		

C. Developmental stages of disease:

1. The development of any parasitic disease is critically dependent on the life cycle of the pathogen in association with a susceptible host and a favorable environment before the disease condition can be induced.

2. Temperature and moisture are probably the most important factors that affect the severity of plant diseases.

3. The life cycle of a pathogen agent follows these stages:

a. Inoculation -- Contact between host and pathogen agent
b. Incubation -- Pathogen agent (inoculum) begins to develop; spore germination, etc.
c. Infection -- Penetration of plant's surface
d. Disease development -- When plant responds to the invasion of the pathogen in some way. Example: Cells die or abnormalities begin to occur.

NOTE: See Master-3, "Typical Disease Cycle" at end of Lesson.

D. Disease Identification -- See Basic Plant Disease Identification I.-B.,D.

E. Plant disease control -- In most cases plant diseases are controlled by one of the following methods:

1. The use of disease-resistant varieties

2. Cultural control (crop management)

3. Chemical control (mainly fungicides)

III. Types of Fungicides by General Use

Major classifications of fungicides as to mode of action are:

A. Protectant fungicides

1. These are usually applied before the infection occurs to protect the plant from invasion by a pathogen.

2. Protectant fungicides are probably used in a much larger volume than the other type of fungicides.

3. Since the development of most diseases is related to the growth of the plant (especially new leaf growth) and to the weather, the protective cover should be kept on the plant from the time the leaves start to develop until growth stops. Only the portion of the plant actually covered by the fungicide is protected, thus, uniform coverage is critical.

B. Eradicant fungicides

1. As the name implies, eradicants are used for the purpose of eliminating an established infection.

2. These materials generally remain at the point they are applied and do not move in the plant. They are often applied to the pathogene during the overwintering stage.

C. Systemic fungicides

1. Systemics can be absorbed by the foliage or other parts of the plant and move within the plant to some degree.

2. Systemic fungicides may act as protectants or eradicants, or both.

D. Fumigant fungicides

1. These are most commonly used to control soil-borne fungi and nematodes.

2. Fumigants are usually applied as a liquid or solid which converts to a gaseous form for dispersement.

NOTE: Always check the label for "Directions for Use" of any of the above.

IV. Fungicide Classification by Chemical Group

A. A chemical group is a grouping together of the chemicals having some common and related chemical base. Example: The carbamate fungicides are derivatives of carbamic acid.

B. These groups are as follows:

1. Inorganic fungicides

surfur (dust, colloidal, wettable)
copper (powders)
mercury (BANNED FROM USE)

2. Organic fungicides

dithiocarbamates (includes maneb. vapam®, zineb)
thiazoles
triazines
substituted aromatics (includes PCP)
dicarboximides (includes captan)
systemic fungicides (oxathiins - includes carboxia
benzimidazoles - includes benomyl)
fumigants
antibiotics (includes streptomycin)
dinitrophenols (includes dinocap)
quinones (includes dichlone)
organotins
aliphatic nitrogen compounds (includes dodine)

Explanations for each of these groups is contained in Chapter 16 of The Pesticide Book.

V. Planning a Disease Control Program

A. Fungicide used, like other pesticides, should be kept on record--especially for those raw agricultural products entering the market.

B. Keep a record of fungicide use including such things as: Date of Application, Crop(s) Applied To, Common Name of Fungicide, and Dosage Per Acre.

C. Observe all instructions on the manufacturer's label and recommendations of the Cooperative Extension Service.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:

1. Approximately 8% of all pesticides used in the U. S. during 1978 were fungicides. This represents a considerable cost to control plant diseases.

2. Disease-causing organisms are so small in size they cannot be seen without magnification. Consequently, inoculation through infection will have occurred before symptoms of disease are apparent. Therefore, to control a given disease, identification

has to be established for the disease-causing organisms. Not all diseases can be identified by symptoms but require the work of a plant pathologist.

3. For the control of most economic diseases a protectant-type fungicide will be most effective.

4. The fungicides used for controlling plant diseases are many and varied, and categorized in several ways.

5. Fungicides have been used in fruit and vegetable production for many years. More recently fungicides are occasionally used on general crops.

B. Things to be brought out by the class members:

1. Specific uses of fungicides by class members on various crops grown.
2. Problems of disease identification.
3. The degree of control of diseases achieved.

II. Conclusion

A. It is important to know whether the disease is caused by a living organism, a virus, or a non-living cause.

B. Fungi-causing organisms have life cycles. With the use of fungicides the life cycle can be interrupted or controlled.

C. Fungicides are used as protectants, eradicants and systemics.

D. Fungicides are classified by chemical group with chemical name, common name and trade or proprietary name.

E. Every grower should keep records of fungicides used on crops.

F. Follow manufacture's label or Cooperative Extension Service recommendations for use of fungicides.

III. Enrichment Activities

A. Plan a field trip in your area where a commercial orchard or vegetables are grown for the market.

B. Have a grower recap the <u>importance</u> of weed control, insect control and disease control.

C. Invite Extension Specialist in plant pathology from the University of Kentucky to speak to the group.

IV. Suggested Teaching Materials

A. References for Lesson 6

- Fundamentals of Entomology and Plant Pathology
- The Pesticide Book

B. Resource personnel

- Extension Pathologist
- Local sources

C. Audio-visuals

1. Masters

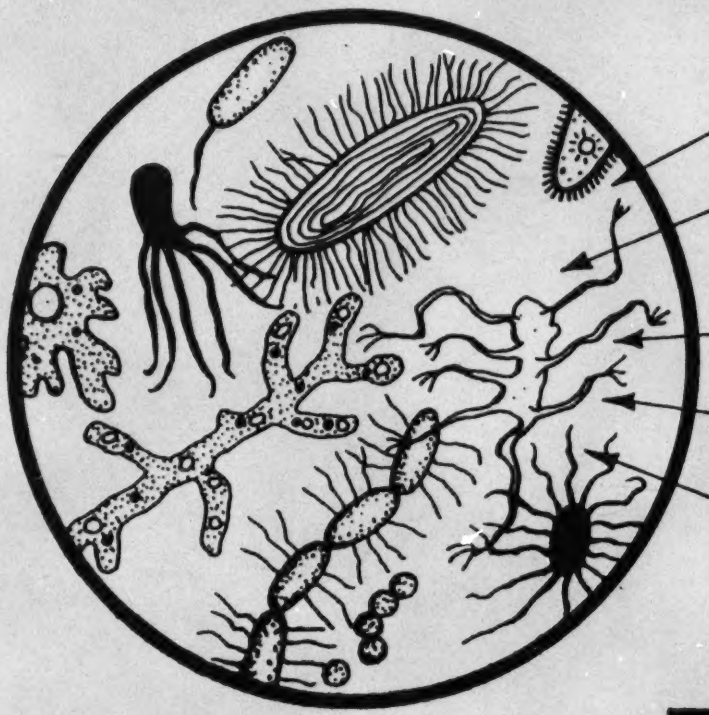
- Record Sheet for Fungicide Users
- Contents of an Acre of Soil
- Typical Disease Cycle
- Names Derived from Plant Parts Affected
- How to be Sure Disease is Involved
- Symptoms of Plant Disease
- Terms Used in Plant Disease Identification

RECORD SHEET FOR FUNGICIDE USERS

Date	Crop(s)	Chemical	Dosage per acre	Remarks

T. VANTRESSE, INST MATL LAB, U.K.

AN ACRE OF AVERAGE SOIL, SEVEN INCHES IN DEPTH, MAY CONTAIN:



- 500 LBS. OF BACTERIA
- 1,000 - 1,500 LBS. OF FUNGI
- 700 LBS. OF ACTINOMYCES
- 200-300 LBS. OF PROTOZOA
- LARGE AMOUNTS OF NEMATODES And ALGAE

PLUS....

- 200 - 1000 LBS. OF EARTHWORMS

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80

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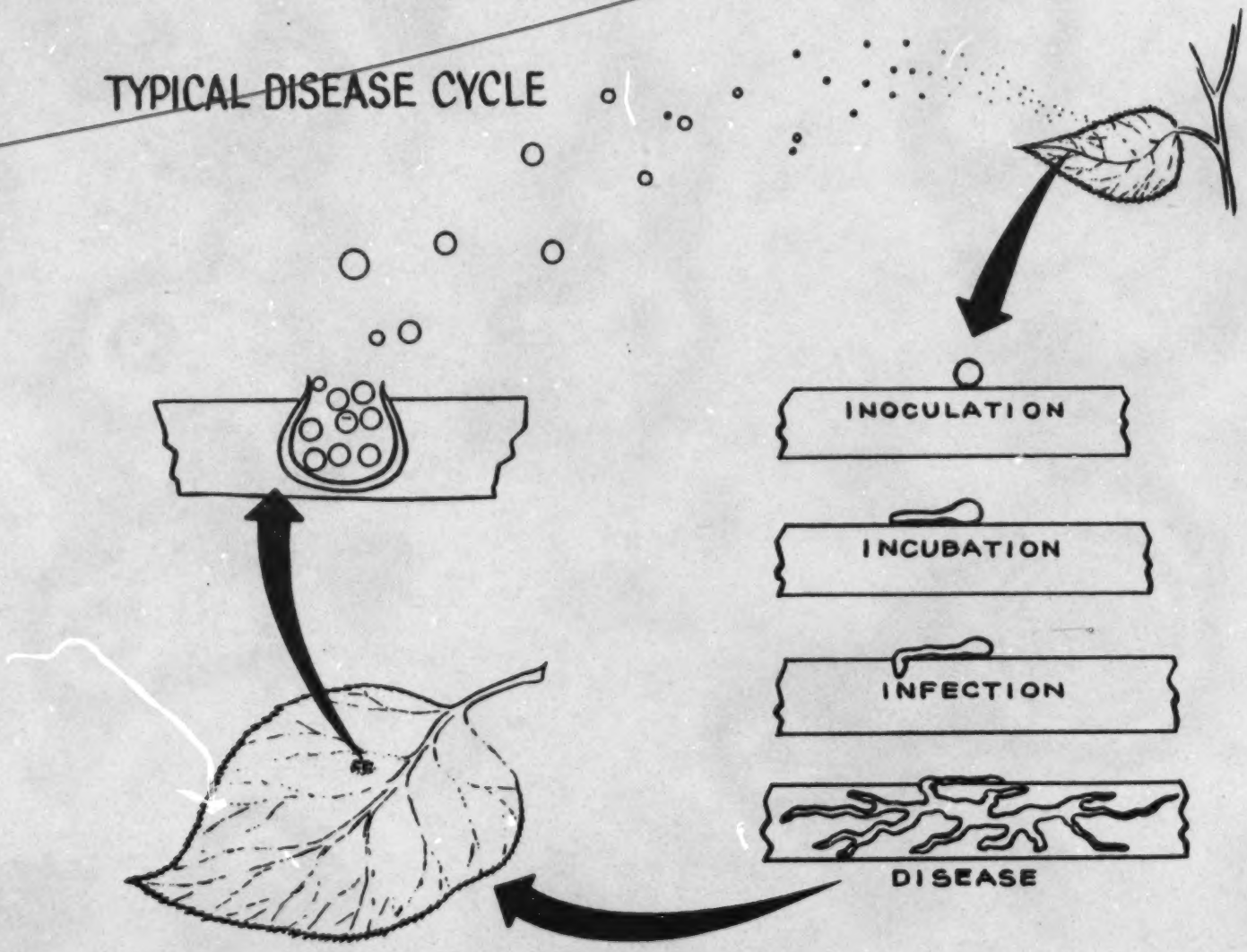
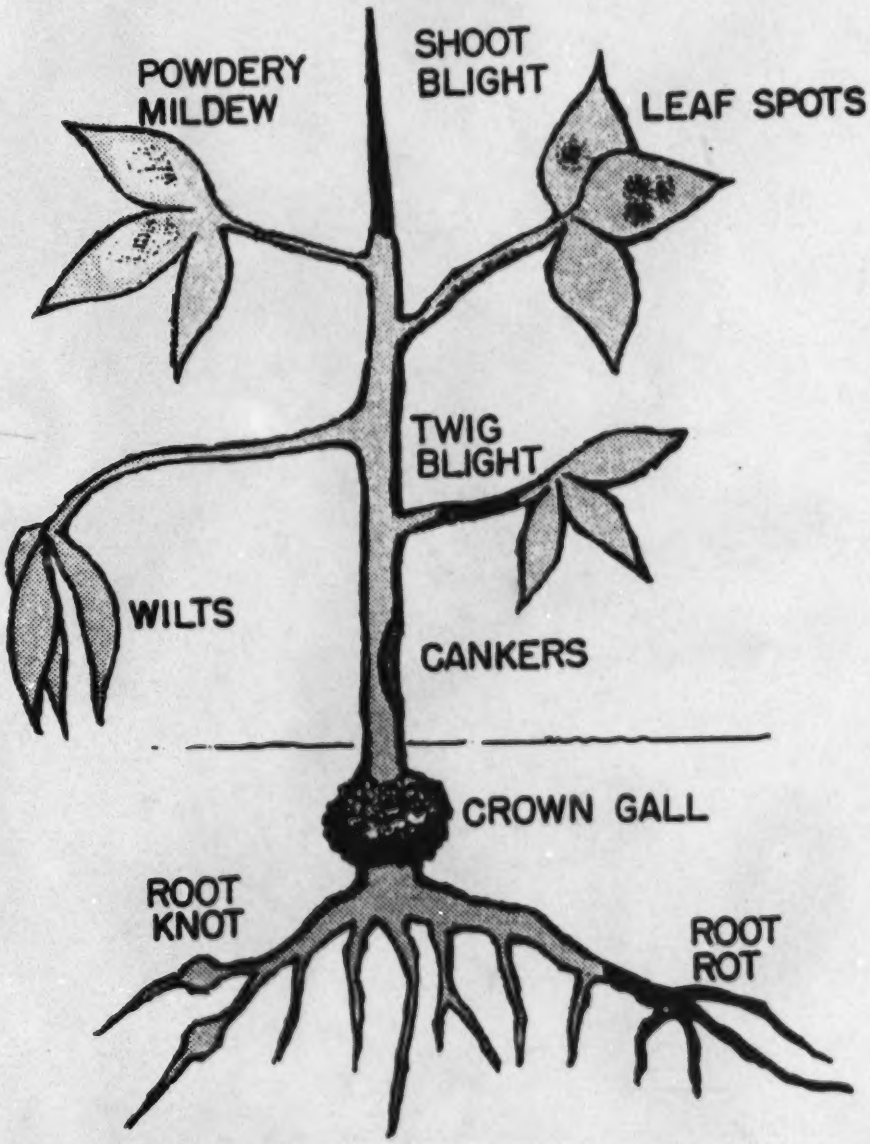
TYPICAL DISEASE CYCLE



SOURCE: Washington State Pest Control Handbook

PLANT DISEASES:

NAMES DERIVED FROM PARTS AFFECTED



SOURCE: Washington State Pest Control Handbook,,p 426 109A-6-4

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HOW TO BE SURE DISEASE IS INVOLVED

Other conditions besides disease can cause the symptoms just mentioned. Before getting damaged plants diagnosed, check to see if the trouble might have been caused by something else.

1. Were the affected plants suited to the area? Exotic plants, such as citrus trees, banana plants, palm trees, etc., selected at random from nursery catalogs may get sick because they are not suited to Kentucky conditions.

2. Could the damage have been caused by insects, pets, children?

3. Were the plants growing in poorly drained soil; gravel; over construction debris like boards, cement blocks, bricks, old driveways; or in other unfavorable environments?

4. Could the damage have been caused by high winds, hail, driving rain, blowing sand; or mechanically by garden tools and power equipment; or by fumes from trash burners or industrial plants?

5. Did the unhealthy plants receive different treatment than the healthy ones, such as watering, pruning, fertilizing, chemical pest control?

6. Do different types of plants nearby have the same symptoms? If so, chances are that plant disease is not involved.

SOURCE: Texas Agricultural Extension, Publication MP-512.

109A-6-5

SYMPTOMS OF PLANT DISEASE

NECROTIC SYMPTOMS

Hydrosis
Wilting
Scorch
Blight
Die-Back
Spot
Rot
Canker
Damping-Off
Bleeding

CHLOROTIC SYMPTOMS

Chlorosis
Yellowing

HYPOPLASTIC SYMPTOMS

Suppression
Etiolation
Dwarfing or Stunting
Rosetting

HYPERPLASTIC SYMPTOMS

Proplepsis
Abscission or Defoliation
Russeting
Discoloration
Galls
Callus
Curling
Scab
Fasciculation

SOURCE: Fundamentals of Entomology and Plant Pathology, Chapter 7.

109A-6-6

TERMS USED IN PLANT DISEASE IDENTIFICATION

The symptoms of plant disease are the clues to accurate disagnosis. Therefore, it's important that the terms used to describe the symptoms mean the same thing to you as they do to a pathologist. The following are common terms in describing disease symptoms:

ABSCISSION OR DEFOLIATION

The premature falling of leaves, flowers, or fruits, caused by formation of the abscission layer.

ALBICATION

The complete suppression of green color in normally green tissues.

BLEEDING

The continuous oozing of sap from wounds or injuries.

BLIGHT

Rapid discoloration and death of tissues over certain parts of the plant. Used as a general way to describe a disease condition which may include spotting, sudden wilting or death of leaves, stems, flowers, or entire plants. Usually coupled with the name of the plant part affected, like twig blight, blossom blight, tip blight, cane blight, leaf blight, etc.

BURN

A condition in which the cells of the plant become reddish or dark-brown and collapse.

CALLUS

New tissue growing over a wound in an attempt to heal it.

CANKER

A definite dead area, usually on woody stems, surrounded by live tissue.

CHLOROSIS:

Yellowing of normally green tissues. Many diseases cause chlorosis, and often the pattern of the chlorotic area helps to diagnose the disease.

CURLING (ROLLING)

A puff-like distortion of a leaf resulting from the unequal development of its top and lower surfaces.

DAMPING-OFF

A disease of young seedlings caused by soil-borne fungi. Infected seedlings topple over and die just after they emerge from the soil. In some cases, seedlings may "damp-off" before they emerge from the soil.

DIE-BACK

The dying backward from the tip of foliage, twigs, or branches of trees and shrubs.

DISCOLORATION

Abnormal coloration of tissues and organs other than yellowing or chlorosis.

DWARFING OR STUNTING

The underdevelopment of any organ of the plant or the entire plant.

ETIOLATION

Excessive spindliness accompanied by dwarfing of foliage and flowers and lack of natural chlorophyll development.

EXUDATE

Any substance formed inside a plant and discharged through a natural opening or wound.

FASCICULATION

Abnormal development of twigs or roots about a common point.

FLAGGING

Loss of rigidity and drooping of plant parts, usually because of water deficiency.

GALL

A pronounced localized swelling or outgrowth, often more or less spherical and composed of disorganized cells.

HAIRY ROOT

Development of an abnormally large number of small roots in a small area of the root.

HOST

The plant which is invaded or parasitized by a disease producing agency. The "host range" refers to the various kinds of plants that are affected by a specific parasite.

HYDROSIS

Water leaving the cells and filling up the intercellular spaces.

KNOT

A knob-like growth on roots or stems.

LESION

A localized spot of diseased tissue. Spots, cankers, blisters, scabs, etc. are lesions.

MOLD

Any fungus that produces a superficial, often woolly growth, on various types of organic matter or on plant parts.

MOSAIC

Disarrangement of the chlorophyll content of plant tissue, especially leaves, resulting in dark green and light green, or yellow areas forming a variegated pattern. Typical symptom of some virus diseases.

MUMMY

A dried, shrivelled fruit, the result of some fungus diseases, such as brown rot of stone fruits.

NECROSIS

The death or disintegration of cells and tissues.

PATHOGEN

An organism capable of causing a plant disease.

PROLIFERATION

Abnormal bush-like outgrowths.

PROPLEPSIS

The development of shoots from buds that normally remain dormant.

PUSTULE

A pimple-like or blister-like growth on a plant surface caused by infection with a pathogen.

RHIZOMORPHS

String-like strand of fungus hyphae.

ROSETTING

The crowding of the foliage into a rosette formation.

ROT

A state of putrefaction or decomposition.

RUSSETING

The brownish, superficial roughening of the epidermis of fruits, tubers, and other structures.

SCAB

The abnormal thickening of the outer layer or layers of tissue resulting from local irritation.

SCALD

Blanching of epidermal tissues that turn pale brown or darken.

SCORCH

Burning of tissues.

SHOTHOLING

A disease symptom in which small roundish fragments drop out of leaves giving them the appearance of having been riddled by shot.

SPORE

Pertaining to fungi, it is a propagative unit that may be considered analogous to the seed of green plants.

SPOT

Term applied to more or less discolored circular or angular lesions on foliage, fruit, or stems.

SUPPRESSION

The failure of certain organs to develop at points where they normally develop.

VECTOR

An agent that may carry or transmit the cause of a plant disease.

VIRULIFEROUS

Capable of transmitting a virus.

WILT

Loss of rigidity and drooping of plant parts. Similar to flagging except a wilt usually involves a greater portion of the plant.

WITCHES BROOM

A broom-like growth produced by the dense clustering of branches.

YELLOWING

Loss of green color due to degeneration or disorganization of chlorophyll or chloroplasts. Comparable to chlorosis.

SOURCE: Texas Agricultural Extension Publication, MP-512.
Fundamentals of Entomology and Plant Pathology

109A-6-7E

Lesson 7

UTILIZING MISCELLANEOUS PESTICIDES

Objective: To develop the ability to utilize miscellaneous pesticides in controlling the less-common pests.

Problem and Analysis: How should we use the miscellaneous pesticides for controlling less-common pests on the farm?

- Rodenticides
- Acaricides (miticides)
- Avicides
- Nematicides

Content

I. Rodenticides

A. Definitions

1. The Winston Dictionary defines rodent as:

a. Gnawing; biting
b. Like a gnawing animal
c. Pertaining to an order (Rodentia) of gnawing mammals having strong incisor teeth, including the rats, mice, squirrels, beavers, groundhogs, and the like.

2. The term rodenticide as spelled out in the provisions of the Federal Insecticide, Fungicide and Rodenticide Act, "means any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating rodents or any other vertebrate animal which the Secretary shall declare to be a pest."

B. Rodents cause great losses in the following ways:

1. Loss of food -- In some developing countries, as much as 20% of the grain is consumed by rats. Consumption is not the only problem associated with rats. Contamination of foodstuffs is another problem that is of greater economic loss than what is eaten.

2. Diseases -- Diseases borne by rats and other rodents are many. No dollar value can be fixed on the misery and death caused each year by rat-borne diseases.

3. Property loss -- Property loss due to rats is accounted for in the following ways:

a. Damage to electrical wire insulation, causing electrical short circuits to start fires.

b. Damage to other electrical equipment systems. Example: communication systems.
c. Rat burrows undermine and weaken building foundations and embankments used for water-holding purposes.

C. Principles of rodent control -- While the following mainly concerns the rodents, rats and mice, it only seems logical that similar applications can be made to other rodents.

1. Rats and mice seek food and water.

a. The Norway rats eat from 3/4 to 1 ounce of dry food and 1/2 to 1 ounce of water per day. The roof rat requires 1/2 to 1 ounce of dry food and up to 1 ounce of water per day while the house mouse requires 1/10 ounce of food and 3/10 ounce of water per day. In searching for these materials, the Norway rat ranges usually no more than 100 to 150 feet. The roof rat ranges the same distance while the house mouse ranges only up to 30 feet. This should be kept in mind when arranging locations for poisons or traps.
b. Nesting and harborage areas will be selected that offer the most security in relation to nearest potential food and water supplies.
c. Burrowing -- The Norway rat is predominately a burrower and builds many tunnels and numerous exits. In using fumigation type control these exits will need to be located and filled or stopped-up.
d. Migration -- Migrations may be classified as non-recurring and seasonal migration. Non-recurring are presumably caused by crop failures, floods, etc. Seasonal migration occurs quite frequently on farms, from buildings and storage areas to fields in warm weather and return during cold weather.

2. The following fundamental principles should be kept in mind in undertaking control measures:

a. The number of rats in any given area is directly proportional to the amount of food and harborage available.
b. Rats live in a highly competitive environment and any reduction of food and harborage increases this competition.
c. An increase of competition by the manipulation of the rats' environment will result in a decrease of the rat population.

D. The following procedures would be applicable for a control program on individual farms, as well as in a community control program:

1. A well-planned and executed sanitation program is essential for effective results.

2. Proper sanitation consists chiefly of adequate refuse storage, collection and disposal practices.

3. Timing of rodenticide application is of prime importance. The application of rodenticides must precede any clean-up of refuse, removal of harborage and ratproofing.

E. Types of rodenticides and characteristics

1. Phosphorus: The chemical phosphorus is seldom used today for rodent control. Zinc phosphide (a single-dose poison) is used against rats, mice, and gophers.

2. Coumarins (Anticoagulants): This group of rodenticides has been used most successfully in rat control. They work by inhibiting the material in blood (prothrombin) necessary for clotting and by causing internal bleeding. Warfarin is the best known product in the coumarin group. It has been used since 1950. An interesting feature of this bait is that rats do not develop bait shyness even though they must ingest the product over a period of days. This provides a safety factor for other animals if they should accidentally eat the poison.

3. Organochlorines: These substances are no longer used because because of environmental hazards associated with their persistency.

4. Indandiones: Three compounds in this class have the same anticoagulant characteristics as Warfarin. They are used in instances where bait shyness is a problem for Warfarin.

5. Botanicals: An older rodenticide was Red Squill (1935). It came from the powdered bulbs of a plant and was not too effective. Strychnine in the form of strychnine suflate has been used as a rodenticide. It is highly toxic to all warm-blooded animals and has been replaced by the anticoagulants.

6. Miscellaneous: Compound 1080 and a related Compound 1081 are used as rodenticides. However, Compound 1080, because of high toxicity, is not available to the general public. VACOR® is an acute toxicant that kills in a single dose. It is effective against Warfarin-resistant rats.

F. Planning the control program -- The type of rodenticide to use in the planned control program depends largely upon safety conditions with respect to humans, livestock, and pets.

II. Acaricides (miticides)

A. Review of mite classification

1. Mites belong to the order Arachnida.

2. Mites and ticks belong to the class Acarina (hence the term acaricide). The only difference between mites and ticks is a difference in size; the latter are much larger in size.

3. Differentiation of mites and ticks from spiders or insects can usually be made at a glance because the mite body consists of two regions. Also, mites differ from insects in having four pairs of legs and in having no antennae, true jaws or compound eyes. A curious feature is that newly hatched young have only three pairs of legs, but acquire the fourth pair later in maturity.

4. The life cycle, or metamorphosis, is more nearly akin to no metamorphosis (egg-young-adult).

5. Mites have sucking mouthparts and feed by drawing out plant juices. They may appear at any time during the growing season, but are most destructive during hot, dry weather.

6. There are several species of mites which are most commonly identified by common names such as European Red mite, Two-spotted or "Spider" mite, Spruce mite, Pear leaf blister mite, Clover mite, Grain mite and others.

B. The economic importance of mite control can be easily understood by way of comparison; lack of mite control could mean the difference between success or failure for many growers, including fruit growers, vegetable growers, ornamental horticulturists and greenhouse operators.

C. Miticide types and modes of action

1. Contact
2. Systemic

D. Miticide classifications

1. Organosulfurs: Aramite® is probably the oldest of this group (1951). The organosulfurs are used only for mite control because of low toxicity to insects.

2. Formamidines: Some products in this group have been removed from sale; however, they do work differently than the organophosphates and carbamates and may be useful for pests resistant to these products.

3. Dinitrophenols: Morocide is used exclusively for an acaricide.

4. Organotins: This group includes Plictran®, a very selective acaracide.

E. Formulation of miticides as to method of application

1. Sprays -- wettable powders (WP), emulsifiable concentrate (EC), emulsifiable liquid (EL)
2. Dusts (D)
3. Oil Solutions (OS)

F. Residues and tolerances for miticides have the same significance as for insecticides. Always follow the label or spray guide recommendations.

G. Farmers should plan a mite-control program when planning their insecticide-control program.

1. Because a crop requires insecticide control does not necessarily mean that a miticide is required for that particular crop.

2. Effective mite control depends on good spray or dust coverage, proper gallonage, and full-strength dosage. Follow label directions to determine if repeat applications are required.

III. Avicides

A. Avicides are substances used to control pest birds. Generally they are not designed to kill, but only to repel or to so affect a few individuals that others are frightened away.

B. Some common pest birds are: pigeons, starlings, English sparrows, and blackbirds. (See pictorial key to some common pest birds of importance to public health, Master-5, at end of lesson.)

C. The following are examples of avicides:

1. Avitrol® - a repellant resulting from the distress calls of affected birds.
2. Starlicide - chlorinated compound that is slow acting.
3. Fenthion - perch treatment
4. Ornitrol® - chemosterilant used as a birth control agent for pigeons.

NOTE: These are for illustrative purposes only.

D. To properly utilize avicides:

1. Comply with state and federal legal requirements.
2. Contact proper officials for recommendations and assistance.
3. Some avicides are for professional use only and are not for sale to the public.
4. Some avicides require federal and state permits.

E. Other tactics used to scare birds away include flagging, carbide exploders, and the removal of tree branches to keep the canopy from being so dense and attractive to bird roosting.

IV. Nematicides

A. Economic importance

1. Nematodes have considerable importance as injurious parasites of plants, animals, and man. It is the parasitic nematodes on which we want to focus our attention.

2. Nematode damage has often been attributed to other causes. It is only in the last 40 years that we have paid attention to nematodes, primarily because of better equipment available today, such as the electron microscope.

B. Classification of Nematodes

At present, no universal system of classification exists. Ten major orders of nematodes are existent in soil. Two of these orders are concerned with plant parasites. To date, more than 10,000 species have been described, yet this is still a small number of the total.

C. Description of Nematodes

1. They are cyclindrical unsegmented worms, possessing a digestive tube with both mouth and anus and a body cavity.

2. Many nematodes are free-living and many are parasitic; the great majority are parasitic.

3. Nematodes range in length up to thirteen inches or more (those parasitic to animal and man) and one sixty-fourth to one-quarter of an inch for plant-parasitic nematodes. Most kinds can only be seen through a microscope.

D. Nematode identification

1. Since nematodes are usually too small to see, the only way to detect their presence is to have plant specimens and/or soil examined by a plant nematologist or to depend on your own ability to recognize damage symptoms.

2. Nematode symptoms are often like those characteristics of any sick or unhealthy plant due to insects, disease, nutritional deficiencies, moisture conditions and other typical injuries.

3. To determine if nematodes are present:

   a. First examine the soil or plants to eliminate likely causes mentioned.
   b. After examination and failure to positively identify nematodes present, take a soil sample and/or plant material to your county extension agent to forward the sample to a plant pathologist.

E. Plant-parasitic nematodes may be classified based on some particular characteristic or habit:

1. Cyst formers -- Soybean cyst nematode.
2. Root-penetrating nematodes (endoparasitic) -- Potato root nematode.
3. Root-knot nematodes -- Barley root-knot nematode.
4. Root-lesion or meadow nematode -- Corn nematode.
5. Nematodes that feed on root surfaces (ectoparasitic) -- Example: Stylet nematode.

F. Nematode control -- Nematodes may be controlled by:

1. Cultural practices presently appear to be the most economical way of controlling nematodes on low-value crops.

   a. Crop rotation, resistant plant varieties, and sanitation practices are essential for maintaining control by cultural practices.
   b. Cultural practices work best against species which have a limited number of hosts.

2. Nematicide treatment

   a. Nematicides control a wide range of soil nematodes and are practical for high-value crops such as vegetables and flowers.
   b. Overall soil fumigation of an entire field (broadcast) can be done in one of five ways:

      1) Plow application. Plow applicators deliver the fumigant into the furrow as the soil is turned (requires immediate sealing).
      2) Tooth or chisel application. These applicators are attached to the tractor mounted cultivators; the chisels or teeth are spaced 10 to 12 inches apart. The chisels place the fumigant 6 to 8 inches in the soil by means of tubes attached to the chisel (requires sealing).
      3) Row treatment. In row treatment, the fumigant is applied only to the narrow strip where the crop is to be grown.
      4) Irrigation application. Fumigant is metered into irrigation water.
      5) Side-dressing established plants. The fumigant is injected on both sides of the row with power equipment. (Caution -- Check for plant tolerance listing.)

G. Nematicide Types and Formulations

1. Halogenated Hydrocarbons: This group includes DD and EDB, methyl bromide, and Tetrachlorothiophene. These are in emulsifiable concentrate, granule, fumigant, or soluble forms depending upon the particular product used.

2. Organophosphates: Only a few of the systemic insecticides are useful as nematicides. These include dichlofenthion, prophos and phorate, among others.

3. Isothiocyanates: This group contains three nematicides - SMDC, MIT, and DMIT.

4. Carbamates: Aldicarb is an oxime nematicide that has recently been registered. It is applied in granular form.

H. Planning a nematicide control program

1. Where nematicide are known to be a problem for a specific crop, a control program should be applied using cultural methods or nematicide control, depending on the range of crop value.

2. In using nematicide control, combining of the cultural practices, in addition to use of nematicides, would strengthen the overall program.

3. Keep records on fields or areas treated and fields under suspicion.

4. Until sufficient experience has been gained, secure the help and recommendations of a nematologist.

Suggestions for Teaching the Lesson

I. Developing the Situation

A. Things to be brought out by the teacher:

1. The pesticides falling under the category of "miscellaneous pesticides" should not be misconstrued as being unimportant. In fact, taken individually and where the need exists, they are just as important as any pesticide discussed.

2. It is granted, however, that volume-wise, these pesticides are not sold in quantity like herbicides, insecticides, and fungicides.

3. Rodenticides have a place in the pest control of most farms. Few if any farms are immune from rodents.

4. For commercial vegetable growers, ornamental, greenhouse producers and fruit growers, miticides are an important link in pest control.

5. The use of avicides for pest bird control may be essential in many different types of farm operations. Here, we are dealing with a public relations-type situation in pest control and should follow federal, state and county guidelines strictly.

6. Many farmers today are following continuous cropping programs (omitting crop rotations), this type of program does not encourage nematode control. In some areas of specialized crop production, the use of nematicides is already essential.

B. Things to be brought out by members of the class:

1. Experiences in maintaining good rodent control.
2. Existing needs, if any, for mite control and experiences in maintaining mite control.

3. Experiences in pest bird control.
4. Existing needs, if any, for nematode control and experiences of these that have used nematicides.

II. Conclusions:

A. By proper sanitation and supplementary use of rodenticides, a good rodent control program can be maintained.

B. Miticide use is important in producing many specialized crops.

C. It is important to select materials that are known to have miticidal value. (Not all insecticides are miticides.)

D. In using avicides for pest bird control, base your decision on the economic standpoint.

E. Some avicides require a permit for use.

F. Check with the proper federal, state or county officials for recommendations for pest bird control measures.

G. For low-value crops, nematodes can more economically be controlled by using cultural practices; sanitation, resistant varieties, and crop rotations.

H. For high-value crops, the use of nematicides is practical and feasible.

I. Keep grower records when using rodenticides, miticides, avicides, and nematicides.

III. Enrichment Activities

A. Take a field trip to a place where a successful program is being carried out using any one of the miscellaneous pesticides.

B. Invite local Extension Agent or Extension Plant Pathologist to demonstrate damage and/or control methods.

IV. Suggested Teaching Materials

A. References for Lesson 7

- Complete Guide to Pest Control
- The Pesticide Book
- 1981 Insect Management Recommendations for Field Crops and Livestock

B. Resource personnel

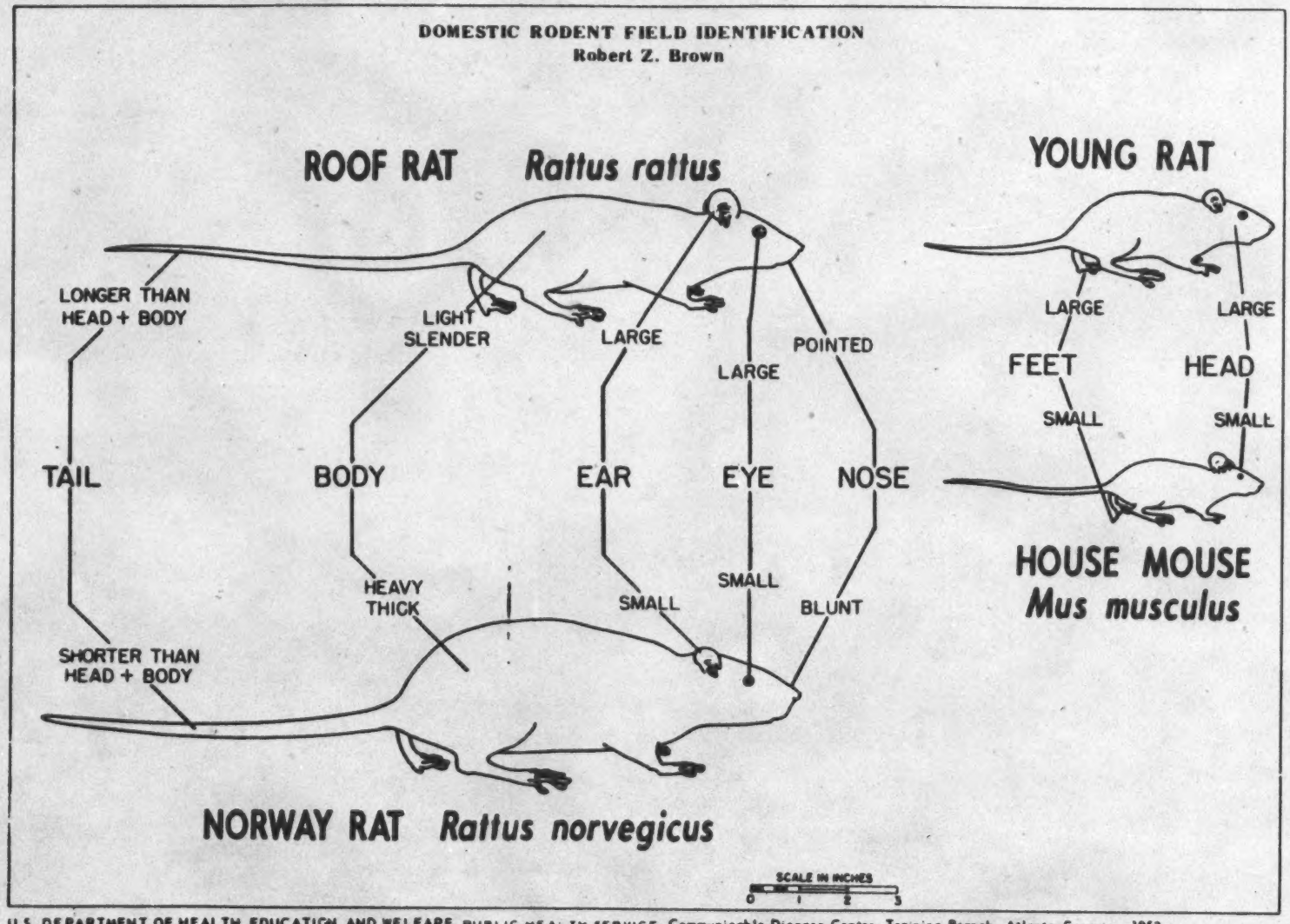
- Contact local sources

C. Audio-visuals

1. Masters

- Domestic Rodent Field Identification
- Rodents: Pictorial Key
- Morphology of the Mite
- Pictorial Key to Some Common Pest Birds
- Life Cycle of the Barley Root-Knot Nematode

W.O. 1044-34



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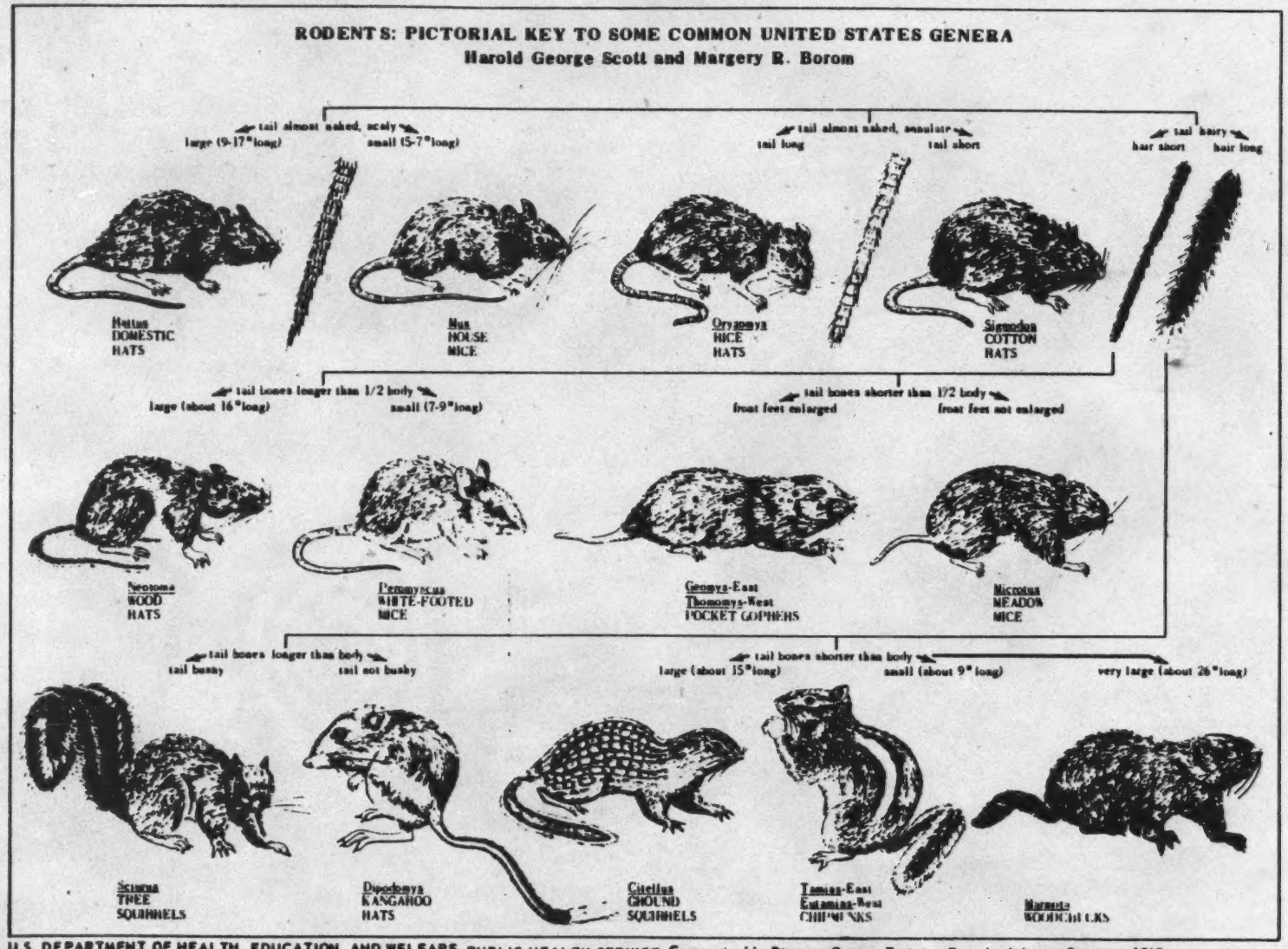
RODENTS: PICTORIAL KEY TO SOME COMMON UNITED STATES GENERA

Harold George Scott and Margery R. Borom



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, PUBLIC HEALTH SERVICE, Communicable Disease Center, Training Branch, Atlanta, Georgia – 1962

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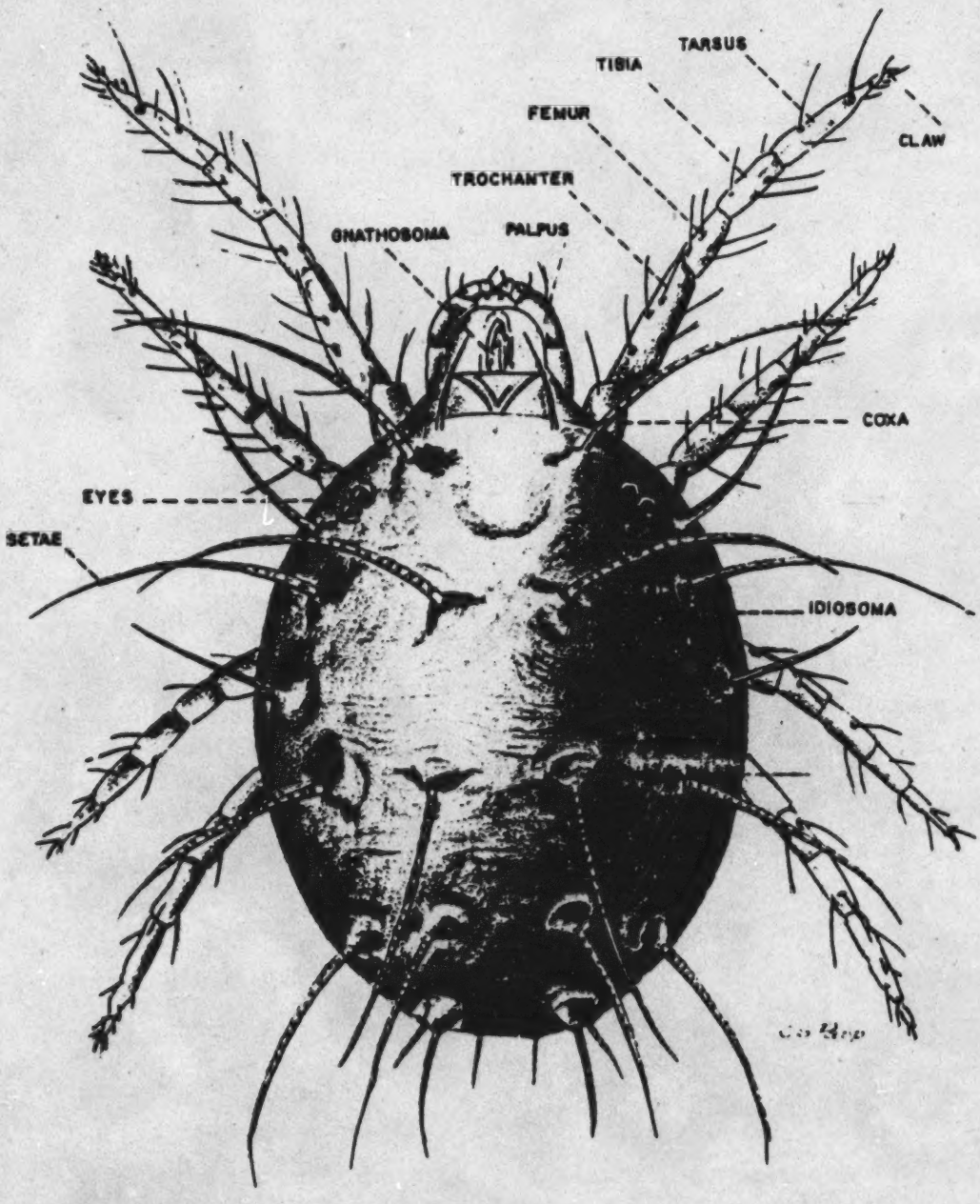

Greatly enlarged detailed drawing of citrus red mite.

SOURCE: American Fruit Grower.

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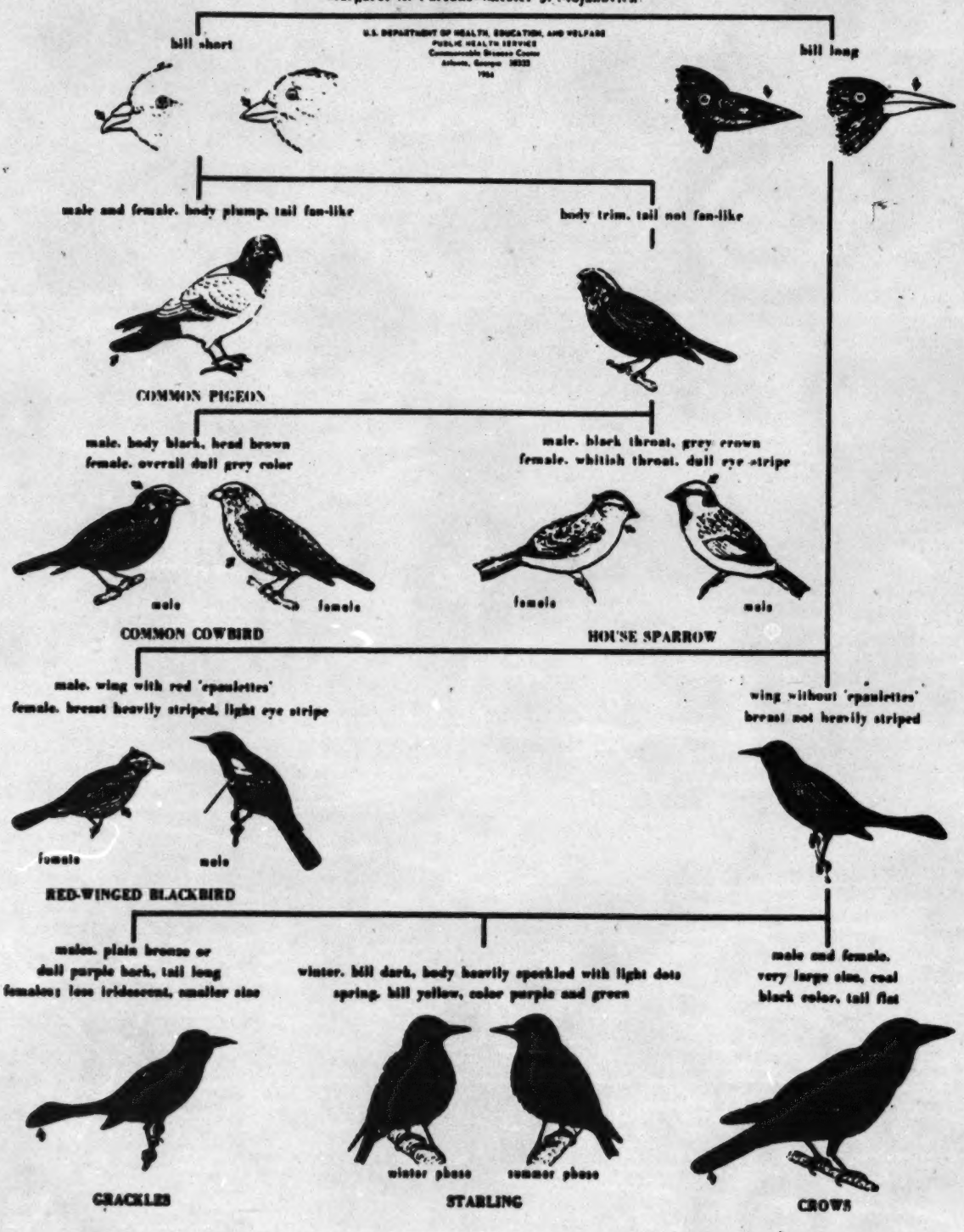
PICTORIAL KEY TO SOME COMMON PEST BIRDS OF PUBLIC HEALTH IMPORTANCE

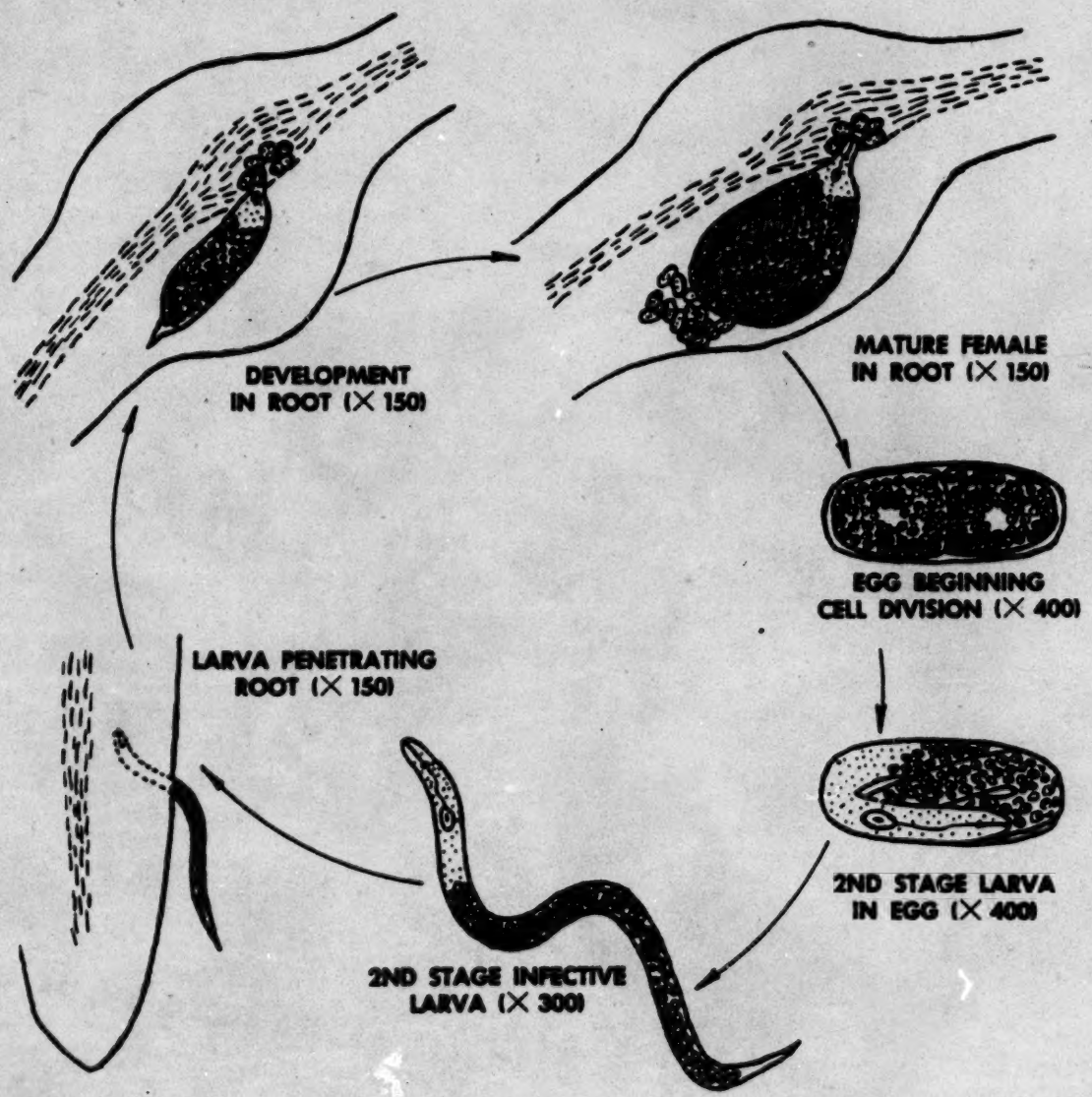
Margaret A. Parsons—Chester J. Stojanovich

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
Communicable Disease Center
Atlanta, Georgia 30333
1964



W.O. 1048-35

Life cycle of the barley root-knot nematode



SOURCE: Crops and Soils Magazine, March, 1971.

109A-7-5

WD. 1048-39

APPENDIX

Please complete and return to:
John W. Dickens
#46 Dickey Hall
University of Kentucky
Lexington, Kentucky 40506

INSTRUCTIONAL UNIT EVALUATION

A Questionnaire for Kentucky Vo-Ag Teachers of Adults

PART I -- GENERAL INFORMATION

How many years of teaching experience do you have? _____

How many years have you taught adults in agriculture? _____

How long has it been since you have taken your last college classwork in agriculture? _____; in education _____; (undergraduate, graduate, or non-credit course)? _____

What is the highest degree you hold? _____

How many teachers are in your department? _____

What age level students do you teach? (✓ one)
a) _____ high school only b) _____ high school and adult c) _____ adult only

How many other units from the University of Kentucky have you used in your teaching during the past few years? _____

PART II -- UNIT INFORMATION

NAME OF UNIT EVALUATED? _____

TYPE OF CLIENTELE TAUGHT: _____ Adult Farmer _____ Young Farmer
_____ Other Adults (please specify) _____

Average number attending class _____

Was the interest level _____ high? _____ moderate? _____ low?

How many lessons did you use? _____ How many class periods? _____

Indicate any lesson you added or deleted _____

_____

Directions: Place a check mark (✓) in the appropriate left hand column to rate the following components of the unit based on your own observations. A ranking of 5 represents an excellent rating decreasing to a rank of 1 for poor. For the open-ended questions please write on the back if additional space is needed.

Unit Design

5 E	4	3	2	1 P	
_____					General arrangement of parts
_____					Appropriateness of format for teaching adults
_____					Lengths of the unit
_____					Usefulness of suggestions for using the unit
_____					Number of lessons
_____					Order of lessons

Specific comments: _____

_____

PLEASE CONTINUE ON NEXT PAGE

Objectives in the Unit

5 4 3 2 1
E P

_____ Clearly stated
_____ Reasonable to reach in the allotted time
_____ Relevant to needs of the adult learner
Specific comments: _____

_____

Technical Content

5 4 3 2 1

_____ Sufficiently detailed for direct use in class
_____ Related to objectives
_____ Divided into appropriate problem areas
_____ Up-to-date
_____ Accuracy
_____ Reasonably complete
Specific comments: _____

_____

Suggestions for Teaching the Lessons

5 4 3 2 1

_____ Appropriate information for the teacher to bring out
_____ Appropriate items to be secured from class members
_____ Suitability of enrichment activities
Specific comments: _____

_____

Resources and Teaching Aids in the Unit

5 4 3 2 1

_____ Up-to-date
_____ Accessibility to the teacher
_____ Relevance to the unit
_____ Adaptability to the teaching plan
Specific comments: _____

_____

With what parts of the unit do you feel you need additional help?

_____ None of them
_____ Objectives
_____ Content
_____ Course organization and planning
_____ References
_____ Resources and teaching materials
_____ Teaching methods
_____ Other (Specify) _____

PART III -- GENERAL REACTION

Please indicate any other strengths and weaknesses that you have observed in the unit and any suggestions for improvement, revision, and/or implementation (use additional sheet if needed).